(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, E. A. AVERILL, Editors.

AUGUST, 1909

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and shop. The children go to work not because they want to, but because they have to become little bread-winners. Here, then, are many children working in some capacity, and a series of public schools carried on only for those who are fortunate enough to be able to continue in their school work. Since the public school system is the only organized institution capable of dealing with all these children at work, and since the children are also learning a trade and earning money sufficient for their simple wants, it seems that the only complete solution of the problem is a system of co-operation between the schools and the factories for efficiency training and civic training of the young people after they have found their work.

"The fundamental principle of the co-operative system is very simple. It is this: the technique or the practical side of the work is taught only in a shop or store which is working under actual commercial conditions, and the science underlying the technique can be taught properly only by skilled teachers. All questions as to who shall supply the school teachers (the shops or the public); the hours the student works, and the hours he is taught; the periods of alternation of shop and school work, if alternating periods be used; and the curricula of the schools—all these are matters of detail to be considered for each particular case.

"The economy of the system is at once apparent. In an engineering school, for instance, twice the number of students can be taught at about two-thirds the expense as compared with the four-year theoretical system. The same is probably true in industrial education, for under the co-operative plan the schools will not require any physical equipment; all their money can be used for brains and for buildings for teaching purposes only. There is a further economy to the student. In this case he is earning while he is learning, while under the trade school system he does not earn until he has completed his course.

"At Fitchburg, Mass., the co-operative system is a part of the public school system. The students are divided into two groups which alternate every week. That is to say, this week one-half of the students are in the day school and one-half are in the factories. Next Monday morning these groups will change, and those who are in the school this week will go to the shops, and those who are in the shops this week will go to the school. Since the public school becomes a part of the apprenticeship system, it has a voice in the organization of the apprentice course in the shop, and is *in loco parentis* to the boy, so far as his shop work is concerned. It ought to be obvious that the boy will receive a fair training in the shop because the school is in a measure watching over this phase of his work.

"It is not intended, of course, that this plan should apply only to factories. It will apply to a boy learning the tailor trade, the butcher trade, the baker trade, or any other trade. It is necessary, however, to obtain two boys to alternate in the shops."

THE WORK OF THE RAILWAY BUSINESS ASSOCIATION.

The opinion grows that the whole country is under obligation to the Railway Business Association for its effective part in restoring confidence and starting business. This many of the railroad presidents declare, while expressing their appreciation of the beneficial effect upon railroad companies. The head of an Eastern trunk line said the other day: "The good which has been done by that association has not been limited to the railroads alone; in fact, the general public, who were suffering from the effects of business inactivity, have been the largest beneficiaries. The association has done much toward better general business conditions, and for this is deserving of the thanks of the public at large." Another official, vice-president in charge of maintenance and operation of an important line running out of Chicago, remarked recently: "We do not regard the Railway Business Association as being in any wise organized in behalf of corporations, but it is to advance the welfare of every honest employer and employee."

These officials are not quoted with any apprehension that their approval will be misunderstood. At the beginning of the campaign the officers of the association showed anxiety lest the public should believe the effort was being financed by the railroads, instigated and controlled by them. Nobody who has followed the career of the organization can now reasonably suffer misapprehension on that score. Not only is it perfectly evident to experienced observers that the policy and efforts have been distinctly those of business men accustomed to mercantile activities, rather than of railroad officials adjusting themselves to new conditions as to public relations, but the most emphatic acknowledgment is heard on every hand from railroad presidents themselves of the independence of the railroads which the association has maintained.

An extremely conservative railroad president, head of one of the most extensive systems, went so far as to concede: "Above all, the Railway Business Association is to be congratulated upon the perfect frankness which has characterized everything it has done. Its independence has added materially to its influence." Similar approval from another important source high in railroad management was that: "The Association has unhesitatingly urged publicity of corporate accounts and corporate actions, coupled with fair legal restraints and a reasonable degree of government control."

It is impossible for a representative of a journal in this field to travel about without becoming aware that the railroad officials are surprised and delighted with the policy of the organization. As one of them operating in the far West expressed it: "While the railroads would undoubtedly be willing to help with contributions, I do not think this step could be taken without impairing the usefulness of the work."

The officers of the association express themselves as deeply gratified at the results of their work thus far. The executive and special committees are in constant conference, so that everything undertaken is carefully studied and discussed. There has recently been a steady increase of new members, indicating that whatever doubt there may have existed in some minds as to the feasibility and permanence of the organization is disappearing. To have won the confidence first of the railroad supply interests as indicated by the membership roll, next of the railroad officials as shown by the quotations given above, and finally of the public as proved by the respectful heed given to the suggestions of the association in the matter of pending legislation, may well be looked upon as extraordinary success for an association only eight months old.

The foregoing paragraphs were submitted at the headquarters of the association with a request for additional notes and met with the following statement:

"The Railway Business Association has every reason to be gratified by the reception which has been accorded its efforts. If any qualification of this expression were to be made it would be to say that there are still many concerns vitally concerned in restoring and maintaining the purchasing power of the railroads who have not yet handed in their applications for membership. The potency of our organization is directly proportioned to the number and influence of the units composing it. The more employees of industrial establishments we represent through their employers who are members of the association, the more careful attention to our requests we may expect from legislators and administrative officials. At this time, when the federal administration is understood to be seeking permanent solutions of the problems in regulation of corporations, railroad as well as others, it would measurably assist our efforts for conservatism if we might have immediately a large number of new members."

MASTER MECHANICS' ASSOCIATION

(*Continued from page 288.*)

FUEL ECONOMIES.

Committee:—W. C. Hayes, Chairman; R. P. C. Sanderson, D. R. MacBain, T. B. Purves, Jr., W. H. Wilson.

The committee prepared and had sent out to all members of the association a list of questions bearing on the subject of the progress made in fuel economy from a practical standpoint, and to those questions many replies have been received, the tenor of which is that the question of fuel economy is receiving considerable attention from the officers of many railroads in this country. From a few of them it is getting specific and close study, with a fuel department detailed to work out the problem, commencing at the mines to inspect and select the coal and have it prepared for use as well as it can be before shipment is made to the different points on the various systems. The idea is to make an effort to have the coal thoroughly cleaned and as free from slate and all other noncombustible matter as is possible, so that when it is distributed to the several coaling stations the best results can be secured from it. If this is done as fully as possible there will be an inspiration for the engine crew using it, and for all those whose duty it is to supervise its use from the mines to the fire box, so that much greater fuel economy must result.

Comparative tests have been made of bituminous and briquetted fuel. While the data obtained were quite interesting, it was quite clearly demonstrated that the value of briquettes as a fuel in comparison with coal is far from favorable, as shown from the fact that only 6.30 pounds of water were evaporated per pound of briquetted fuel from and at 212° F. as compared with 8.83 pounds of water evaporated per pound of bituminous coal.

In connection with this test it was observed that the flame was very much shorter with briquettes than with bituminous coal, while it is quite essential that the long flame should be maintained at all times in the deep fire boxes. On account of the briquettes not producing a long flame those making the test were under the impression that fuel of this kind would be more satisfactory in shallow fire boxes instead of deep ones, although the engine in which the test was conducted was not what might be considered a deep fire box.

It was also found that the action of gases upon the eyes of the firemen was unfavorable, as complaint was made in regard to it, due, it was assumed, to the binder employed in making briquetted fuel.

As an example of the amount of fuel wasted at the pops some tests made by the C. M. & St. P. Ry. in 1905 with four different types of engines to determine the average coal consumption in a locomotive while standing on a side track coupled to a train of twenty-five air-brake cars are given. During the test the boiler pressure was uniformly maintained at within 10 pounds of maximum pressure, the reservoir air pressure maintained at 85 pounds and the train-line pressure kept at 66-68 pounds. The temperature was about 50 degrees above zero.

Engine Class.	Kind.		Coal Per Hour.
H-5	17 by 24 inches,	8 wheel	128.125
G-4	19 by 26 inches,	10 wheel	131.25
B-3	15 and 25 by 26 inches,	10 wheel	161.25
B-5	15 and 25 by 30 inches,	10 wheel	177.5

In some instances, particularly on one of the larger systems, it is intended to purchase coal from specifications made up by the mechanical department, but as yet this practice has not been developed far enough to give an elaborate explanation of it to this convention. It is sufficient to say that there is at present a thorough coal inspection system installed with competent coal inspectors located at the mines to continually inspect and mark all cars set aside for company use. The inspector has authority to reject any and all coal that does not meet the specifications of the company. He also makes it his business to frequently send samples of coal from any and all cars loaded for company use for test and analysis to the chemist, to whom the coal inspectors report. It is also within the province of the mechanical department to see that the coal is distributed to the different points on the system at the least possible cost; price and hauling, as well as handling and quality best suited to use in certain territories, being considered.

The mixture of the poorer with the better grade of bituminous coal, and of anthracite and bituminous coals in specified percentages, have been established by the proper officials of the mechanical department.

The placing of coal on engines in large sizes is not conducive to fuel economy, as, by doing so, too much of the fireman's time is taken from watching the fire in order to properly prepare the coal for use, or it is introduced into the fire box just as it comes from the mines, altogether too large for economic results. It is very evident that it will pay to see that coal is placed upon the engines in suitable sizes for firing, so that the fireman may be able to devote his entire time to watching, controlling and feeding his fire.

In the opinion of the committee, the base of the whole question of fuel economy is contained in beginning at the mines, so as to be absolutely sure that no imposition is practiced by having noncombustible material palmed off for coal, and to see that the coal is properly cleaned. To do this it will be found necessary to keep competent inspectors at the mines with authority to reject all coal before shipment that does not come up to certain standard specifications upon which all coal should be purchased.

It is believed that the time is rapidly approaching when the production of all mines will be purchased upon their value as shown by a complete chemical analysis. This is true of coal at the present time only to a small extent, but the number of contracts made based upon the number of B. T. Us. that can be furnished for one dollar is bound to increase every year. The road above referred to furnishes data sheets showing just what B. T. Us. are furnished in each kind of coal used for one dollar, to officials engaged in the extension of fuel economy. The purchase of coal on specification is as much of an advantage to a railroad company, or to any buyer, as a definite understanding of a building operation or engineering project is to the engineer, because when coal is bought to a specification you get what you pay for and pay for what you get.

When the bidder is allowed to specify the quality of coal he proposes to furnish as determined from a chemical analysis, he is placed on a strictly competitive basis with other bidders. This broadens the field for both the bidder and the purchaser. The cities of Chicago, Indianapolis, Minneapolis, St. Paul, St. Louis and Cleveland purchase coal on this basis, as do some of the other large cities. There is, however, some variation in the B. T. Us. allowed by the different cities which purchase coal on this plan, but in general a standard is fixed at nearly 14,000 B. T. Us. Coal falling below that standard may be used or not by the purchaser. If, when an inferior grade is used, an average is struck when the monthly settlements are made, it can be plainly seen that the material reduction in the prices of the coal will soon cause the mine owners to sit up and take notice. The result will be that the standard fixed in the bid will be maintained.

One of the essential things which many of the railroads are now trying to establish is to figure on the grade of coal best suited to a certain territory, to then assign this coal to that territory and have it definitely understood that no change will be made except in case of a grave emergency, such as a miners' strike, floods, storms, washouts, etc. This will enable engine crews to become acquainted with the quality of fuel furnished. Engines can then be drafted to suit, and thus insure greater improvement in fuel economy than if the old plan was continued.

The proper essentials of fuel economy and the conditions obtaining in a locomotive boiler on which that depends, should be as follows:

1. A clean boiler whose shell, tubes, sheets, and stays (and in addition "the crown bars," in the crown bar type of boiler), are kept free from mud and scale.
2. Properly drafted and good steaming engines.
3. A good quality of fuel properly prepared for use.
4. Efficient operation of the locomotive.
5. Individual fuel records.
6. A full and fair accounting.

Economy in the use of fuel on a railroad is at all times a very interesting, though perhaps a perplexing problem. There are so many items, which enter into its make up, both from a mechanical and an operating standpoint, that the fuel question is always bobbing up and presenting itself for solution. The fuel account being one of the chief items of expense on every railroad, all officials having charge of train and engine men should work together in order to secure best results. To do this, we are very much inclined to think there should be a mutual understanding concerning the leaks, and a combined effort should be made to stop every one of them.

1. *A clean boiler.*—The first essential to be dealt with in considering the question of fuel economy is the boiler or source of supply.

The reason that it is so important that the sheets be kept free from mud and scale is that the heat given off by the burning of the fuel may be more readily absorbed by the water through

the sheets than would otherwise be absorbed by the mud and scale, representing an absolute loss in heat and a consequent waste in fuel, with all the other evils which travel in the wake of boilers not properly taken care of, such as leaky flues, stay bolts and fire-box sheets, which carries with it the delays on line incident to that condition of boiler.

Provision should be made in the design for a good free circulation of the water and also to see that flanges are properly turned, so that no traps are formed to accumulate dirt and scale. The care of the boiler should be closely looked after, both as to proper blowing out at terminals and on line during every trip. This, together with good washing at terminals and proper care in handling, will extend its life and usefulness and materially aid fuel economy. The study and attention now given to locomotive boiler design as compared with some years ago is marvelous. This is a good thing. The care now given to locomotive boilers in service by all railroad companies will undoubtedly materially assist in the promotion of fuel economy.

2. *Properly drafted engines.*—Improperly drafted engines are perhaps one of the greatest sources of trouble on many of our railroads to-day. It therefore goes without saying, that it is entitled to and requires constant and close supervision and attention, because on account of some defect in the draft apparatus that has escaped notice, much waste of fuel occurs.

Insufficient draft may be caused in a number of ways. First, in the fire box, by the grates being clinkered. Second, by the heat of the fire not being fully utilized because the engine crew are not educated up to a point of appreciating the importance of the subject, or through their neglect of the proper essentials of fuel economy in the performance of their work. Third, through a lack of the proper vacuum being formed in the front end or smoke box by the exhaust steam.

The proper remedy can and must be applied after a thorough investigation of the subject has located the difficulty.

It is not considered necessary in view of the knowledge of the members of this association concerning draft appliances, to mention the value of the different devices other than to say that what is known as the master mechanics' standard, strictly adhered to, gives most satisfactory results.

3. *Good quality of fuel properly prepared for use.*—In order to get the best results, the coal should be placed on the tenders of the engines in such a size that the firemen can devote his entire time and attention to watching and feeding the coal to the fire. Anything which interferes with his doing so is at the expense of a certain amount of coal wasted. We do not undertake to say how the above can be accomplished on any railroad, on account of the different methods of handling fuel, employed on docks or coal tipples, and thence to the tenders of engines, but we contend that the better the coal is prepared before being placed on engines the more economical its use will be. The first section of the proposition hardly needs restating, that is, furnishing a good grade of fuel tends to its economical use; it is our firm belief that all classes of enginemen will do better work, and will use greater effort to save the good coal in all ways than will be the case when a poor grade of fuel is furnished. We are fully aware, however, that in some instances this has not proved to be the case, but the causes which led up to that belief are so indefinite as to be of no value in determining the above question. If this is true, it follows, then, that the proper preparation of coal for firing has considerable influence on the completeness and rapidity of combustion, and consequently on the temperature obtained in the fire box and on the prevention of black smoke.

The rapidity with which a lump of coal will burn depends, among other things, on the amount of its surface presented to the fire, so that if the lump is broken into a number of small pieces it will present a much greater surface, will burn faster, and will create a much higher temperature with the same quantity of coal on the grates. Other advantages are that the smaller coal can be spread more evenly over the fire, a thinner fire can be maintained and the thickness of the fire can be regulated more readily for the proper admission of air through the grates, thereby securing a higher and more even temperature in all parts of the fire box, and, as naturally follows, also a better combustion of the fuel.

The portion of the air supply furnished through the ash pan cuts a very important figure, and, doubtless all will agree, is very essential in assisting combustion to an extent that the best means for furnishing it should receive considerable attention.

4. *Efficient handling.*—This involves the work of both the engineer and fireman, and, to our minds, constitutes one of the most, if not the most important element in fuel economy.

The question of running an engine in order to get most economical results involves the work of both the engineer and fireman, and is so important from that point of view that we shall introduce this portion of the subject by making the following statement:

An engine may be built of the very best material, and of the most approved design, *i. e.*, mechanically perfect, with all the modern conveniences to assist in its perfect manipulation, and you place that machine in the hands of an incompetent engineman and you have almost nullified the combined expert mechanical skill necessary to turn out the finished product. We think you will all agree it is most important that the finished machine should have skilful operation.

This is largely a question of education by beginning with the future engineer and training him from the time he enters the service in the way you would have him go in regard to the duties of a fireman, and subsequently with regard to the duties of an engineer, establishing an educational qualification as a condition of employment, and later requiring such examinations from time to time as will tend to bring out his fitness for the duties of a fireman, and his application of them.

The manner of firing and feeding water to a boiler has much to do with its steaming qualities. To get best results, these two operations must be performed in harmony with each other.

The engineer should so regulate the water in his boiler as to have a sufficient quantity to enable him, when starting from a station, to shut off the injector while his train is being brought to speed, in order that the fire may be given every advantage and the steam pressure maintained at the maximum. The fireman may be ever so capable and may do his best to make a good coal record, but if the engineer does not perform his work with a view to economy, the fireman's efforts will prove futile. The fireman may save by the ounce while the engineer wastes by the pound, if they work independently of each other. This would certainly be considered very poor management, as both must work together in order to get best results. The engineer should be taught never to work his engine harder than is necessary, consistent with the train to be hauled and the time to be made, and that it is not always the man who makes the most noise pulling out of a station who makes the best time on the trip, because by that very act the draft on the fire may be of such a character as to cause his engine to fail before she gets to the next station, and the engineer in charge may be unable to assign it a cause. The fireman should be taught that heavy firing is wasteful, and should always be avoided; that the introduction of large quantities of coal at one firing absorbs very large quantities of heat, and reduces the temperature of the fire box below the igniting point of the volatile gases, allowing them to pass out of stack unconsumed in the form of black smoke. Then, again, the greater the volume of gases the more difficult it is to mix them with air, which is absolutely necessary in order to effect complete combustion.

Variation in the temperature of the fire box has also other bad effects. It causes alternate contraction and expansion of the sheets, which in due time result in leaky flues, cracked sheets and broken stay bolts.

The above effects will be present in a much less degree when the coal is fired in smaller quantities, and for this reason it is desirable to use only a small amount at a time and fire more frequently. The quantity to be fired at a time depends largely on the work to be done, the quality of the coal used, and the size of the engine. No hard-and-fast rule can be made, but it is safe to say that the best results can be obtained by using small quantities and firing often. The firing should be done at regular intervals, and the fire door closed after the introduction of each shovelful, and it will be found to be a good practice to keep the door closed a few moments after each shovelful, so that the temperature of the fire box will have time to recover from the effects of the last opening.

Every shovelful should be spread over the surface of the fire as evenly as possible, and the sides and the corners should be kept well built up and covered. If the coal is piled into the fire box in heaps it will burn slowly like so many individual chunks of coal, besides acting as a blanket at that spot, the result being that clinkers are formed and the engine steams poorly.

Did you ever stop to think what it is costing railroad companies for the steam wasted through pop valves unnecessarily? If you have not, the following figures will doubtless surprise you. The figures can only be based on estimates as to the number of engines that may be included in the list. Nearly 15 pounds of coal are wasted through a 3-inch pop valve every minute during which it remains open, and a pop rarely opens and closes in less than a minute. Our observation, as far as the control of pop valves is concerned, unless exceptional care be practiced, is that 3 per cent. of the boilers upon any railroad are blowing off continually during the twenty-four hours. If this be true, a few figures will demonstrate just what the waste is: 2 per cent. of 1,000 engines is about the number that will be found to be blowing off day and night. This we consider a conservative estimate. This would waste in the vicinity of 78,840 tons of fuel per year; computed on the present average price per ton would amount to the snug sum of $111,164.40. Just think of paying that amount for a leak which ought to be stopped and can be, if all railroad officials will unite to stop it. Is it worth the effort? We are inclined to think you will decide in the affirmative.

5. *Individual fuel records.*—This subject has a far greater influence on the coal pile than might at first be thought possible. Our plan would be to have a performance sheet showing the individual fuel record of every engineer and fireman in each dis-

trict, the coal to be charged to the engineer instead of the engine as at present, establishing an average, a maximum and a minimum cost per ton-mile on each district.

We are fully satisfied that, after this sheet has been issued a few times so as to give enginemen an idea of its working, it will stimulate a great interest in the direction of fuel saving. Once let it be understood that such a scheme is on foot, and it will establish a spirit of competition among the men that will mean dollars to the company.

6. *Full and fair accounting.*—This is an item having considerable influence on the fuel. Let the idea become circulated among the enginemen that they are getting the worst of it, in having more or less coal charged to them than should be the case, and you will find that it has a disheartening and a demoralizing tendency, which will militate against the coal pile by creating a "don't care" spirit induced by the idea that they do not get credit for what they do. This feeling should be carefully guarded against.

In conclusion, let it be emphasized that, after going thoroughly into the subject of fuel economy as far as the practical side of it is concerned, we will say that we are of the opinion that best results can be obtained by having the engineers and firemen subject to instruction from the mechanical department only; and for this purpose the road foreman of engines should be on the mechanical staff and report to and receive his instructions from the chief mechanical officer, or his representative. When this is the case the field work is not divided, and much more can be accomplished than when the subject is worked out between two departments.

Discussion.—Mr. Seley stated that the importance of this subject and the one on "Lubrication" was so great that he believed that standing committees on these two subjects should be appointed. Although a motion to this effect was not passed it seemed to be the general impression that the executive committee would provide for an action of this nature.

Angus Sinclair referred to the great importance of purchasing coal on its chemical properties, stating that he believed the fuel purchasing business needed more reforming than the boiler design.

Robert Quayle (C. & N. W.) spoke as follows:

"We will suppose we have the fuel right and the specification is all right, the purchasing agent is all right and the delivery on the ground all right. I made this statement to 22 locomotive firemen within the last two weeks—that I could select 100 locomotive firemen on the Chicago & North Western, and I would guarantee that if I had every other man on the railway equally as good firemen as the hundred I could select, that I could save easily $500,000 a year in fuel. Now, then, if that be true it is a matter of education. It is first a matter of the man's fitness for the job he is filling. Second, it is the education of the man to get him up to that standard where he knows just when to put a scoop of coal into the firebox, and he knows just where to put it; then he knows all the conditions necessary to get the maximum result out of a pound of coal. If he knows all that, the most important thing to follow is to get him to do it, and that is where the railway men are up against it. The problem I have in mind is to get the men to do their best in line with the information they have. I know that when the road foreman of engines or the traveling fireman is on the engine the men do their work splendidly. They keep the decks clean and every pound of coal they handle is utilized in the fire-box, and, as suggested in the paper, their pops are not open and they are not losing a quarter of a pound of coal per second of time the pop is open, but are utilizing the steam generated in the boiler for the engine. They secure the best results from the engine under those circumstances. If there is any man who can point me to the direction I should follow in my efforts to discover how you can get your men to do the best they can all the time, I shall be glad to hear it. I believe there is nothing which you and I can do which will bring greater financial results to the treasury of the railways with which we are connected than to go after the fuel problem and the men who use it."

P. G. Baker (Panama) stated that he believed the sixth proposition of the committee, "full and fair accounting," was the most important and valuable one of all.

Mr. Tonge (M. & St. L.) referred to the effect of dispatching on fuel economy; how often a locomotive is kept on the side track for two-thirds of the time between terminals and the fuel consumed during this time was charged to the engine, although it was no fault of the engine crew that the record is so poor.

Mr. Quayle, in again speaking on the subject, referred to the very great importance of the engineer and fireman working closely together, and said that it is necessary to have complete harmony in the cab if the best results are to be obtained.

Mr. Wildin drew attention to the roundhouse foreman as an important third in the campaign for harmony leading to fuel economy.

Mr. Gaines reported great success with a blank form which was filled out every month and posted in the roundhouse as well as sent to officers interested. This gave engine mileage, coal burned, size of nozzles, etc.

Mr. MacBain (N. Y. C.) suggested that a sufficient number of high-class engine instructors, each to take care of 50 to 75 firemen, whose whole duty should be confined to the matter of saving fuel, would prove a very profitable investment. He stated that most traveling firemen were now largely engaged in post-mortem work and believed that the duties of these men should be altogether instruction of men and not digging out the reason for something that happened weeks before.

TENDER TRUCKS.

Committee:—H. T. Bentley, Chairman; John Hair, A. E. Manchester, J. F. Walsh, T. H. Curtis.

After making investigations and getting replies to certain questions asked, and also from personal observation and experience, we believe that the arch bar, cast-steel side frame, and pedestal trucks, which are now in very general use in all kinds of service, will, if correctly designed, be thoroughly reliable for high and low speeds.

The pedestal type of truck, whether having side equalizers and half-elliptic springs, or with the double-elliptic springs, or with coil springs over the boxes, is a more expensive truck to maintain than either the arch bar or cast-steel side frame type, with the journal boxes rigidly attached.

Under general conditions we do not advise or recommend the use of coil springs over journal boxes, as they increase the wear on box and pedestal without giving correspondingly better results in other directions.

The use of elliptic springs is strongly recommended. For slow service, such as switch and transfer work, coil springs can be used, but we would not recommend them for any other kind of service, because of their excessive movement and number of vibrations before coming to a state of rest.

Side bearings should be used on each truck and in all cases we recommend that their location be less than width of track, or in other words, inside of wheel flanges; if any difference of spread of side bearings is made in the two trucks, it should be greater at rear truck than front one with above limitations, and we would suggest 36-inch centers for front truck and 50-inch maximum for rear truck.

From replies received and from personal experience, we find roller or other kinds of so-called frictionless side bearings are not in general use, and although we have reports of flange wear being reduced where they are used, we are not satisfied that they are necessary, as, with proper clearance between solid side bearings, practically the same results can be obtained.

The use of roller center bearings does not seem to be very general, and the committee does not believe they are necessary for tenders.

While twenty-three replies to letter of inquiry object to the arch-bar truck, and have various reasons—among others, rigidity, breakage of arch bars, number of parts, load not properly equalized, not as smooth riding as pedestal type, difficult to keep in alignment, etc.—yet the committee believes that when properly designed and good material used in its construction, it is entirely satisfactory, and is less expensive to build and maintain than the pedestal truck.

The question of side-bearing clearance is something that has had a great deal of thought on our part, and we recommend that it should be from 1/8 inch to 3/8 inch, and when the side-bearing spread is the same on both trucks, the greater clearance should be on the front bearings, but where the spacing is less on front truck than on rear one, the clearance should be arranged so that both bearings on same side touch together, or at same time.

In regard to tender-truck derailments: The committee, as a result of investigation, find that some tender trucks are more liable to derailment than the trucks under other railroad vehicles, and in answer to a circular of inquiry, the following were reported as some of the causes of tender derailments:

Bad track conditions, high center of gravity of tank, rolling action of water on account of splash plates being out of place, coil springs, short wheel base, shallow center plates, center plates not fitting, too much rigidity, improper location and clearance of side bearings, lack of clearance between drawbar and end sill; on Prairie type engines by excessive lateral swing of engine, depression of track by rear engine driver ahead of front tender truck causing more front trucks to be derailed than rear ones, the steadying effect of cars helping to keep rear trucks on track.

In two cases that can be specifically mentioned, it was found that derailments of tenders on lines where they were frequently occurring ceased when the changes were made as shown below:

No. 1. Arch-bar trucks having swing motion bolster with side bearings spaced 50-inch centers on both trucks, and with about ¼-inch vertical clearance on all side bearings, substituted for arch bar and pedestal truck without swing motion bolster.

No. 2. The trucks in use were arch bar with rigid bolster and cast-steel side-frame types; one tender was equipped with pedestal truck having side equalizers. With each of above type, derailments were of frequent occurrence. The side bearings on above trucks were spaced in some instances 56-inch centers, and others 48-inch centers. The derailments were stopped by spacing side bearings 36-inch centers on front trucks, with ⅛-inch clearance, and 48-inch centers on rear truck with ¼-inch clearance, each side.

In conclusion: We are of the opinion that tender derailments can be practically overcome by the use of properly designed trucks having rigid or swing motion bolsters supported by suitable bolster springs, either elliptical or half elliptical, double or triple, and when side bearings are properly located, having a spacing of 36 inches front where possible, and 48 to 50 inches at rear end. The types of truck may be of the arch-bar or steel side-frame pattern, with journal boxes rigid with the arch bars or side frames; or of the pedestal type having arch bars or solid frames with springs over the journal boxes; or of the pedestal type having side equalizers with half elliptical springs between the equalizers.

The tender should be as long and low as possible. Spring buffers between engine and tender give flexibility and reduce liability of derailment due to solid chafe irons binding or sticking, on account of wear. The buffer face and bearing on engine should be amply large and well rounded to prevent locking. We do not believe that splash plates in tank help to overcome derailments.

Where proper clearance is not allowed between center pin and truck-center casting there is a possibility of truck not curving, and derailments under such a condition are possible; ¼-inch clearance is recommended. Center plate should be flat, and not less than 11-inch diameter set down at least ¾ inch in center plate.

Tender trucks should be built low as possible, consistent with proper clearance. It is absolutely necessary that ample clearance be allowed for free movement of drawbars at both ends of tenders. The front drawbar should be straight, with its center the same height above the track as that of rear coupler, if possible.

The responsibility for either method of hanging brakes (inside or outside) actually causing derailments could not be verified, as both methods are being used successfully, with perfect freedom from derailments when applied to properly designed trucks.

Wheel base of truck should not be less than 5 feet 6 inches, although shorter ones are in service.

Where safety chains are used, they should be of sufficient length to enable truck to go around the shortest curve, and when tender is rocking.

Discussion.—An active discussion followed the reading of this paper. It was decided, however, not to make it public until it had been passed upon by the executive committee. This action was due to the possibility of some statements in the discussion being misunderstood or misconstrued by people who were not thoroughly familiar with it.

MOTOR CARS.

The committee on motor cars, owing to the resignation of its chairman in February, has not been able to make a full and complete report on the subject. Under date of February 17, 1909, the writer (C. E. Fuller) was requested to undertake the work of the chairmanship of this committee.

After due correspondence with the members of the committee and secretary, it was the president's suggestion that a report be made giving a history of the committee's endeavors, and that at the same time I introduce a personal report based upon the experience of the Union Pacific R. R. in operating motor cars.

Within the last few years many types of railway motor cars have been designed, built and operated, some with success, but most types have been discontinued after a period of experiment, due to their inability to meet all requirements from a mechanical and operating standpoint. These cars may be divided into three general classes, as follows:

1. Steam motor cars.
2. Internal combustion motor cars.
3. Electric cars in combination with storage battery, or with one of the above prime movers.

I believe it can be safely said that within the last three years the general trend has been toward the internal combustion motor.

Quite a number of cars of the internal combustion motor type are in operation on steam roads in various parts of the country, and the creditable performance of these cars during the last few years has, I feel safe in saying, done quite a little to allay the original feeling that the internal combustion motor, as adapted to railway service, would always be an experiment. Some of the advantages of the internal combustion cars, as developed in the use of this type of car on the Union Pacific, are:

1. Light motor weight, permitting lighter truck and body construction.
2. Elimination of the energy-generating unit, such as boilers, tanks and battery.
3. Convenience and compactness in carrying fuel.
4. Elimination of smoke, cinders and sound of exhaust.
5. Instant readiness of car for service.
6. No power losses nor expenses when shut down.

The present considered standard motor car, put in service by the Union Pacific R. R., is a 55-foot all-steel car, equipped with 200 horse-power motor, and carrying 75 passengers, car weighing 60,000 pounds. A similar car 70 feet long has been built, seating over 100 passengers and weighing 80,000 pounds. It will be seen that the dead weight carried amounts to from 660 pounds to 800 pounds per passenger, which compares favorably with modern automobile practice. Fuel sufficient for a 300-mile run is stored in a single tank of convenient size, located in an out-of-the-way place, and it is fed automatically until the last drop is used. Dead cars have actually been placed in commission on five minutes' notice.

These advantages particularly fit this type of car for operation where fuel cost is excessive or where conveniences for handling and maintaining steam or electric cars do not exist.

At the present time the Union Pacific has fifteen motor cars in service, the following services being operated:

Run	State	Cars Assigned	Distance in Miles	No. Road Trips Daily	Total Mileage
Kearney-Callaway	Neb.	2	65	2	260
Loup City-St. Paul	Neb.	1	39	2	156
Beatrice-Lincoln	Neb.	1	40	2	160
Omaha-Valley	Neb.	1	34.8	2	139
Lawrence-Leavenworth	Kan.	1	34.3	1	68
Lawrence-Kansas City	Kan.	1	38.9	1	78
Sterling-Greeley	Colo.	3	97.6	2	390
Boulder-Brighton	Colo.	1	27.7	2	111
Omaha-Council Bluffs, over Mo. River Bridge	Neb.	1	2.8	24	134.4

This leaves three cars for protection of the various runs and for swing cars when any of the above assigned cars are shopped.

On the Kearney-Callaway, Loup City-St. Paul, Omaha-Valley, Lawrence-Leavenworth, Sterling-Greeley and Boulder-Brighton runs the motor cars haul a trailer, trailer being used for baggage and express and for mail where required.

Seven of the earlier cars placed in service on the Union Pacific were equipped with 100 horse-power engine. Five of these 100-horse-power cars are still in service. The regular or standard type of car in service is equipped with a 200 horse-power six-cylinder reversible gas engine, coupled with a Morse silent chain and a friction clutch to the front axle of the car, which carries 24,000 pounds, or approximately forty per cent. of the entire weight of the vehicle, and gives ample adhesion under all circumstances. Two speeds are used—a low, or geared, speed for starting, and a high, or direct, speed for running. Both speeds are available for running backward. The more recent cars differ from the earlier car only in slight details. The side entrance has been introduced instead of rear entrance, with the idea of doing away with the accumulation of ice and snow on car steps, also obviating the use of step box. Owing to the fact that some of the services have now outgrown the capacity of the 55-foot cars, we are arranging to introduce a 70-foot type of car.

The cars are operated on branch lines by a crew of two men, consisting of motorman in the engine room and a conductor to take tickets, handle orders, etc.

The motor cars have no difficulty whatever in maintaining a passenger-train schedule, and in addition stopping for passengers, when flagged, at road crossings. The operation of these cars shows a very heavy passenger traffic development, which, while partially due to the increased frequency of service, is, however, due to the accommodation in making these road-crossing stops.

Discussion.—For special branch line operation, Mr. Seley reported that the Rock Island Railroad had tried two different types of steam cars, one of which was entirely unsatisfactory, and the other, now in operation, is fairly satisfactory. He stated that the success of a motor car depended more on operating conditions than mechanical features, and thus far this road had found difficulty in placing a motor car where it could meet with continued service that would be satisfactory from the operating standpoint.

President Vaughan, in speaking on this subject, said:

"I might say, gentlemen, that we have had some experience with the motor car. Before we got a motor car, the passenger business of the road depended on our developing a motor car. After we got a motor car we could not find any place in which we wanted to use it. That has been our experience for the last three years. Personally, I do not believe, unless the gasolene motor car can be made a satisfactory car, that there is anything in a motor car for railway service. The whole matter of the combining of a steam engine in a passenger coach is, to my mind, radically wrong. The proper place to put a passenger coach at night is in the passenger car yard. The proper place to put a steam engine at night is in the roundhouse. If you put a passenger car in the roundhouse, which is full of smoke, the car becomes dirty and grimy and you have got to send your car cleaners from the car yard to the roundhouse to clean the motor car. If you put the car in the passenger car yard, that means that you must send your men from the roundhouse to the passenger car yard to repair the engine.

"There is nothing radical about a motor car. It is simply a small steam engine; it takes about as much coal per mile as any other engine, possibly a little less; it is easier to fire, because it is small; and its capacity is limited.

"We have had cases where our people thought the motor car should pull two or three trailers with ease, and the car will not do it. It is simply applicable for a light service, which, in most of our conditions, which are, of course, rather different from those further south, can be handled by mixed trains better than they can by motor car service. You must, in the majority of cases, run three men, an engineer, a fireman and a conductor, and it seems to me that a very much better solution of the question is to build a little tank engine with a baggage compartment on it, in which you can get a fireman to attend to the baggage and let the conductor look after the tickets. We have prepared designs for such a car, and now await the passenger department to find a place where they want to run it. The motor car question is going along very quietly with us and we are not spending any money on it."

Mr. Sinclair stated that a recent careful examination of the McKeen motor cars at Omaha had impressed him most favorably, particularly in regard to their construction for easy repairs.

Mr. Jacobs (A. T. & S. F.) reported that two McKeen cars on his road were operated most satisfactorily and had developed a most profitable passenger business, there being very little trouble in operation.

C. B. Smith (B. & M.) stated that his road had given the matter of motor cars the most careful study and had decided that they would not be a profitable proposition under their conditions. He drew attention to the fact that a motor car should be arranged for operation at both ends of the car.

E. I. Dodds (Erie) reported that they had had a McKeen car in operation for about two years on several divisions with entire satisfaction.

Mr. Fuller, in closing the discussion, said that a motor car would most certainly not haul a train and should not be expected to, it will haul a trailer, however. A motor car will need attention and repair the same as any other piece of motive power, and it should be put in service on branch lines or sections where the greatest return for the money can be made. It should not be operated between two or three express trains.

BANK VERSUS LEVEL FIRING.

E. D. NELSON.

The method of level firing has been followed largely on the road, and instructions covering methods of firing have described this as the most economical method. The advantages of bank firing were brought forward in the summer of 1908 and tests were undertaken to settle generally and definitely the advantages of this latter method. There were decided differences of opinion on the road as to which method was the better in order to secure freedom from smoke and economy in the use of fuel. To settle this question, the work was undertaken on the locomotive testing plant where uniform conditions and accurate measurements can be obtained.

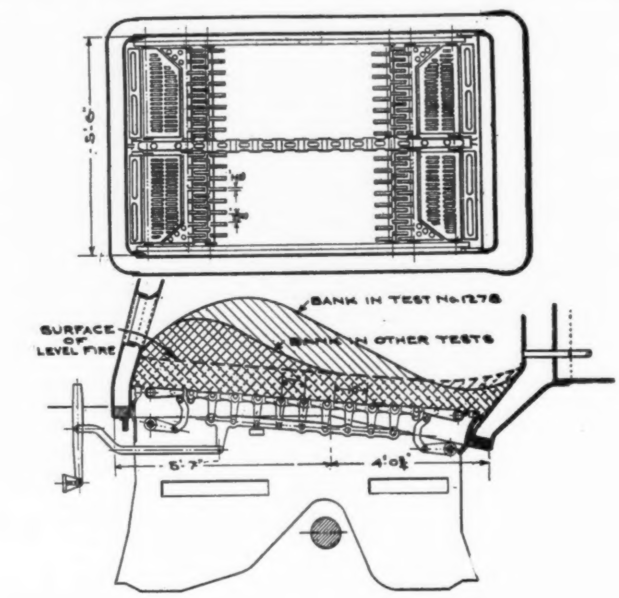
The method referred to as bank firing consists in building up, at the back end of the fire, a bank or ridge of fuel, just inside of the fire door. This ridge of fuel when built up to its full height, has its top at about the level of the top of the fire door. Coal is fired over the top of this bank and slides down the incline toward the front of the fire box, being assisted by the slope of the grate. Coal is distributed along the ridge or bank and finds its way down to the level portion of the fire at the front end of the grate.

The claims of superiority for this method over the level firing are—the fuel, heaped up at the back of the fire box, is coked, the hydrocarbons are driven off slowly and, traversing the whole length of the fire box, are burned with little smoke; the bank of green coal, extending up over the door opening, protects the fireman from part of the heat that is radiated from the fire; the work of placing the fuel is simplified, the coal being fed to the top of the bank instead of being distributed over the grate.

The locomotive used for these tests was the Pennsylvania Railroad standard class "H6b" locomotive, consolidation type, having a total heating surface of 2,505 square feet based on the fire side of the tubes. This is the basis upon which all calculations referring to heating surface are based. The heating surface of the water side of the tubes and the fire side of the fire box, which is usually taken as representing the heating surface of the locomotive, is approximately 2,840 square feet. The grate area of this locomotive is 48.66 square feet, so that the ratio of heating surface to grate surface is 51.49. The steam pressure was 205 pounds.

One series of tests was conducted running the locomotive at about 13½ miles per hour with a cut-off of forty per cent. This gave a drawbar pull of about 22,000 pounds and a drawbar horse-power of about 700. Another series of tests was then run at about 16½ miles per hour with a cut-off of forty-five per cent, giving a drawbar pull of approximately 23,400 pounds, with a drawbar horse-power of 1,030.

The running conditions for these series were selected largely because the conditions stated required approximately eleven pounds of steam from and at 212° F. for each square foot of



heating surface for the first series, and about fifteen pounds for the second series. Road conditions fall generally between these limits. Furthermore, it was arranged that part of each series was run with one kind of coal and part with another. We therefore obtained comparisons with two grades of fuel and two rates of evaporation for both the bank firing and the level firing.

The selection of firemen for this work was not difficult. They were two men who were strong advocates of bank firing and three who believed in level firing. These men were all from the same section of road and the coal hereafter designated as No. 2 is what they were accustomed to using. In addition there were the two regular testing plant firemen and one other fireman from a different section of the road. For the purpose of reference on tables and in the text, these will be designated as follows:

B1—Advocate of bank firing.
B2—Advocate of bank firing.
L1—Advocate of level firing.
L2—Advocate of level firing.
L3—Advocate of level firing.
T1—Testing plant fireman.
T2—Testing plant fireman.
R —Road fireman.

The proximate analysis of the coal used is as follows:

	No. 1	No. 2
Fixed carbon	60.10	48.17
Volatile combustible	30.26	36.37
Moisture	.74	2.04
Ash	8.80	13.42
	100.00	100.00
Sulphur	2.08	3.18

THE LEVEL FIRE.

The methods used in firing the level fire were very much the same in the case of each of the men advocating a level fire. The coal was broken rather fine, to two inches in thickness or less, and was fired in single shovelfuls or at a uniform rate. Fig. 1 shows the section of level fire on the grate.

THE BANK FIRE.

The bank fire firemen did not follow strictly the method of firing the bank fire as given above. A bank, as shown in Fig. 1, was built up, but with the exception of test No. 1278, the bank served only as a protection from the heat and glare of the fire, the coal being fired in small quantities and uniformly over the entire grate, except over the bank. The bank top was about eighteen inches inside of the fire door, and with the bank so short on a practically level grate, it is evident that the coal would not slide by gravity to the front of the fire box. In test No. 1278 an attempt was made to fire by placing all of the coal on the top of the bank. The bank in this case extended about 3½ feet inside of the fire door and the fire at the front of the fire box was very thin.

THE TESTS.

In tests 1277 and 1278, bank fire tests, the same fireman fired throughout the test, but in the other bank-fire tests the fire was prepared by the testing-plant fireman and then turned over to the bank-fire fireman to build up the bank and continue firing to the end of the test. In these later bank-fire tests the bank was allowed to burn out just before the end of the test and the fire had been restored to its first condition at the end of the test. The bank would be burned out in less than seven minutes. All of the firing, both level and bank, was continuous, small quantities being fired at one time and the coal was broken down before firing.

TABLE No. 1.

EVAPORATION AND SMOKE.—No. 1 COAL.

Test Number.	Fireman.	R. P. M.	Cut-off.	Throttle.	Boiler Pressure, Average.	Equivalent Evaporation from and at 212 Degrees F. Per Square Foot Heating Surface per Hour.	Equivalent Evaporation from and at 212 Degrees F. Per Pound of Dry Coal.	Relative Efficiency. Best Evaporation Equals 100%.	Carbon Monoxide, in Gases, Average.	Kind of Fire.	Smoke Number, Average.
					1	2	3	4	5	6	7
1276	L1	80	40	F	197.4	10.84	8.33	91.8%	0.35%	Level	1.4
1275	T1	80	40	F	201.6	11.36	9.07	100.0%	0.60%	Level	1.8
Avg...	...	...	...	...	......	......	......	95.9%			
1277	B1	80	40	F	202.0	11.07	9.04	99.7%	0.95%	Bank	1.4
Avg...	...	...	...	...	......	......	......	99.7%			
No. 2 COAL.											
1285	L3	80	40	F	202.3	10.88	8.68	91.9%	0.10%	Level	1.2
1288	T1	80	40	F	201.0	10.86	9.47	97.0%	....	Level	1.6
1284	L1	80	40	F	203.3	11.08	9.18	97.1%	....	Level	1.4
Avg...	...	...	...	...	......	......	......	95.3%			
1286	B2	80	40	F	203.3	11.09	8.66	91.6%	0.35%	Bank	1.4
1287	B1	80	40	F	202.9	11.04	9.45	100.0%	0.10%	Bank	1.2
Avg...	...	...	...	...	......	......	......	95.8%			

TABLE No. 2.

EVAPORATION AND SMOKE.—No. 2 COAL.

Test Number.	Fireman.	R. P. M.	Cut-off.	Throttle.	Boiler Pressure, Averaged.	Equivalent Evaporation from and at 212 Degrees F. Per Square Foot Heating Surface per Hour.	Equivalent Evaporation from and at 212 Degrees F. Per Pound of Dry Coal.	Relative Efficiency. Best Evaporation Equals 100%.	Carbon Monoxide, in Gases, Average.	Kind of Fire.	Smoke Number, Average.
					1	2	3	4	5	6	7
1279	L2	100	45	F	197.7	14.89	7.35	83.2%	1.05%	Level	2.4
1283	R	100	45	F	199.7	14.85	7.72	87.4%	1.30%	Level	2.1
1289	L1	100	45	F	200.3	14.59	8.07	91.4%	0.15%	Level	1.5
1290	L3	100	45	F	198.4	14.59	8.14	92.2%	0.35%	Level	1.9
1293	T1	100	45	F	197.3	14.29	8.53	96.6%	0.80%	Level	1.7
1281	T2	100	45	F	202.0	15.07	8.57	97.1%	0.45%	Level	2.0
Avg...	...	...	...	...	......	......	......	*91.3%			
1278	B2	100	45	F	193.5	14.21	6.89	78.0%	0.30%	Bank	2.6
1292	B2	100	45	F	198.7	14.66	7.82	88.6%	0.85%	Bank	2.1
1282	B2	100	45	F	200.5	14.88	7.99	90.5%	0.70%	Bank	2.3
1280	B1	100	45	F	201.8	15.07	8.16	92.4%	0.45%	Bank	2.5
1291	B1	100	45	F	200.5	14.51	8.83	100.0%	0 0 %	Bank	1.4
Avg...	...	...	...	...	......	......	......	89.9%			
Avg...	...	...	...	...	......	......	......	†92.8%			

*3½ feet bank. The other tests are with an 18-inch bank.

†Omitting test No. 1278.

On tables 1 and 2 a summary of the results of the tests are given. The tests on table No. 1 were run at a speed equivalent to about 13½ miles per hour and a cut-off of forty per cent, giving an evaporation of eleven pounds of water per square foot of heating surface per hour. The tests on table No. 2 were run at a higher speed, namely, 16½ miles per hour and forty-five per cent. cut-off, giving an evaporation of fifteen pounds of water per square foot of heating surface per hour.

In column 4 of the tables a comparison is made between the evaporation obtained by the different firemen. The highest evaporation for each group of tests is taken as 100 per cent.

Considerable differences are shown between the level-fire firemen. It is very clear, too, that the second test made by some of the men shows a very decided improvement over the first trial on the testing plant.

In the case of fireman "B2" with a bank fire, in test No. 1278, an evaporation of 6.89 pounds is shown, while on the next test, No. 1282, made by the same fireman, an evaporation of 7.99 pounds was obtained, an increase of about 14 per cent. and a saving of 961 pounds of coal in the second test. This would be a saving of about 2,800 pounds over a 100-mile division.

TEMPERATURE NEAR FIREDOOR.

At a point near the firedoor a thermometer was suspended and observations of the temperature were made for each kind of firing, with the following results:

In test No. 1283, level fire, the temperature was 117° F.
In test No. 1281, level fire, the temperature was 114° F.
In test No. 1282, bank fire, the temperature was 104° F.
In test No. 1280, bank fire, the temperature was 94° F.

EVAPORATION PER POUND OF COAL.

In the tests at 100 revolutions per minute the range of coal fired per square foot of grate is from 85 to over 105 pounds. The best results, or highest evaporation per pound of coal, are for the bank fire as fired by fireman "B1." Firemen "T1" and "T2" had had considerable experience at the plant, firing between them seventy-five tests, and the results of their tests with the level fire are very close together.

SMOKE.

Observations of the smoke by the Ringelmann method were made at 10-minute intervals during each test, and the results are conflicting. (See tables 1 and 2.) With No. 1 coal at eighty revolutions per minute the level fire shows the most smoke. At eighty revolutions per minute and No. 2 coal the level fire again shows the most smoke. At 100 revolutions per minute and with No. 2 coal the bank fires show the most smoke.

GAS ANALYSIS.

The amount of carbon monoxide (CO) in the smoke-box gases is dependent upon the completeness of the combustion, a large amount of CO indicating poor air supply and consequent incomplete combustion.

An inspection of the smoke-box gas analyses does not show any marked difference between the two methods of firing. The least quantity of CO was obtained in bank-fire test 1291.

DRAFT AND THICKNESS OF FIRE.

The intensity of the draft at any speed and cut-off depends upon the thickness of the fire, and as the draft does not seem to have been affected by the method of firing, we may assume that the average thickness was the same in both the level and bank firing. The reason for the draft not being greater in test No. 1278, where a thick fire was carried at the back end, is that the fire was very thin in front and most of the air supply for the fire came through that portion of the grate.

CONCLUSIONS.

Of the two methods of firing, the results for the bank firing as practiced at the locomotive testing plant during these tests, show a slightly higher evaporation of water per pound of coal. This is based on the results of the level firing and the bank firing where a short bank was used. The large bank will be referred to later. The result in favor of the bank firing is due, possibly, more to the skill of the fireman than to the methods used. It would, therefore, seem safe to conclude that the amount of coal used with the low bank fire and with the level fire are the same.

If, however, the method of firing as practiced by fireman "B2" in test No. 1278 is followed, the results are much less satisfactory than with the level fire. As the bank firing employed in test No. 1278 was used in the first test with No. 2 coal, to which the advocates of bank fire were accustomed, it would appear that the size of the bank, in this test, and the method of firing it were that which had been claimed to be more economical than the level fire. This method of bank firing is undoubtedly proved to be far from economical as compared with level firing, and the fact that fireman "B2" who formerly advocated this method of firing, changed to the small form of bank after seeing the results,

seems to be corroborative evidence that the large bank, as first tried, was, in his estimation, not to be compared in economy with level firing.

It should be emphasized particularly that in speaking of bank firing as a method, the size of the bank which is to be employed must be clearly understood. The general statement that bank firing and level firing can be placed on a par, so far as economy in fuel is concerned, is misleading, unless a description of the bank method of firing is given.

The idea of the larger bank seems to be that it forms some protection for the fireman against the heat from the fire box and permits the firing to be done largely at the back end of the fire box, the coal or partly consumed coal working its way forward. It is this method of bank firing which has been shown to be uneconomical.

The method of bank firing with the low bank does not require all the coal to be fired at the back end, but requires firing in much the same way as with the level fire. The temperature from this form of bank has been shown to be from 10 to 23° F. less near the fire door than with the level fire.

Discussion.—The president drew attention to the value of a testing plant for obtaining information of this kind which a few years ago would not have been obtainable, and stated that he considered it a great privilege for the association to be able to receive it.

J. F. DeVoy (C. M. & St. P.) stated that he considered the design of fire box had a large amount of influence on the question of the best methods of firing and that his experience showed that a method of firing which was successful on a straight grate would not be successful on a grate with a hump in it.

H. T. Bentley (C. & N. W.) did not agree with Mr. DeVoy that the design of the fire box had as large an influence on the best method of firing as did the character of the fuel used.

C. E. Chambers (C. of N. J.) stated that he had been brought up to fire by the level method and when he came on to a road using the bank system he attempted to change the methods with disastrous results, as it was necessary with the fuel being used to fire by the bank system.

It was reported that the test did not show any noticeable difference in clinkering between the two methods of firing.

CASTLE NUTS.

Committee:—R. B. Kendig, Chairman; J. F. DeVoy, H. P. Meredith, J. N. Mowery, G. S. Edmunds.

(NOTE.—Messrs. John Player and W. L. Austin, members of the committee, did not approve of certain details contained in the report.)

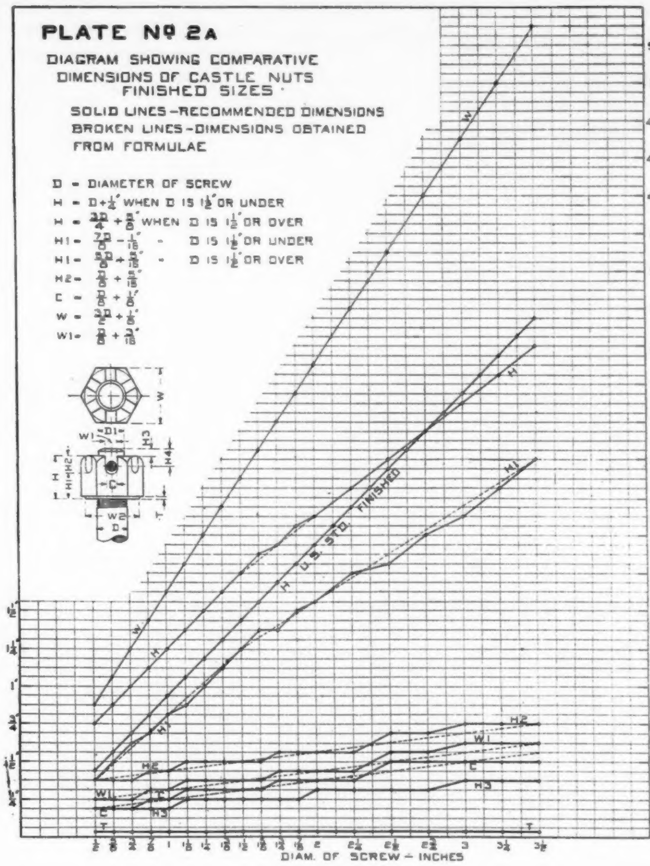
At the convention last year the dimensions of castle nuts as formulated by the committee were recommended for use during the current year, with a view to adopting them as standard if found satisfactory. The committee was continued to get in touch with the manufacturers of castle nuts and with other parties interested, with a view of establishing them as a regular standard of the association.

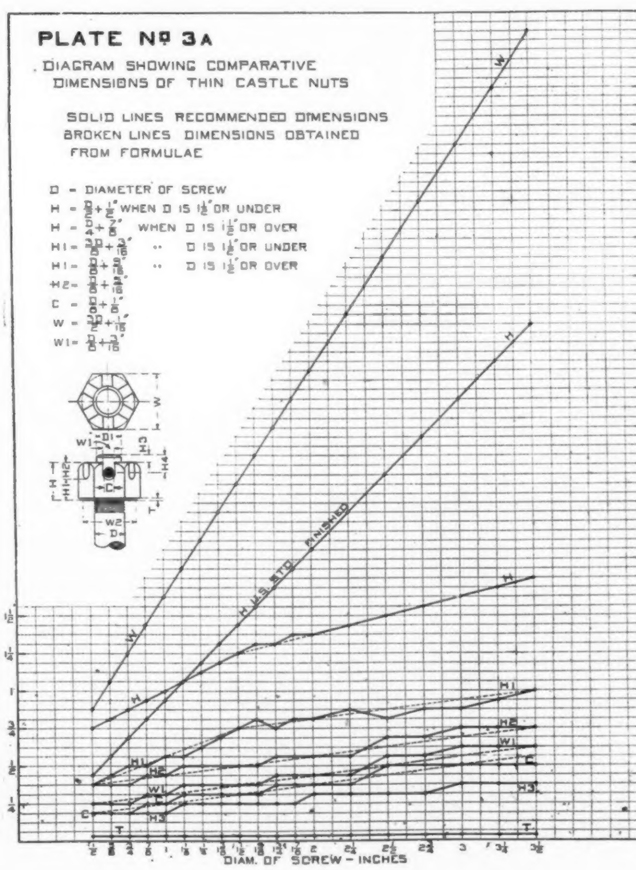
A circular of inquiry was addressed to the members of the association, and similar information was requested from a number of nut manufacturers, with the idea of determining whether or not the dimensions submitted last year were entirely satisfactory. The response to the committee's inquiry would indicate that the subject is awakening more than ordinary interest. The replies received were very complete, and the committe is thus enabled to make some few revisions and some correction of errors in the dimensions, which we believe will now make the dimensions acceptable.

Calling attention to plate No. 4 of last year's report, the committee has prepared plate No. 4-A as a substitute. This revised plate shows all the changes in dimensions, covering corrections and modifications as a result of the answers to our circular of inquiry, as well as the former dimensions which were unchanged.

The committee made inquiry as to the use of the castle nut by members of the association, and find that it is being extensively used on locomotives in all sections of the country. The various parts of the locomotive on which the castle is being used, as reported in replies to the circular of inquiry, include the following: Rod bolts, frame pedestal binder bolts, cross-head pins, cross-head shoe bolts, guide bolts, all valve-motion bolts and pins, brake-connection pins, driving box wedge bolts, spring-hanger bolts, air-pump bracket bolts, chafing-iron bolts, engine-truck radius bar and radius-bar brace bolts, engine-truck frame bolts, radius-bar carrier bolts, engine-truck pedestal bolts, brake-connection pins on tenders, brake-hanger pins, arch-bar and column bolts, and, in fact, on all bolts subject to any motion or wear.

There were reported, however, a number of roads not yet using the castle nuts on account of the excessive cost of manufacture. It is believed by the committee that the adoption of standard dimensions will have a tendency to put the castle nut on a proper manufacturing basis, with the consequent reduction in cost of manufacture. Several of the railroads, on account of the exces-





sive cost, have found it advantageous to equip their forging machines for the manufacture of the castle nut, and from their experience it is evident that the nuts can be thus manufactured at considerably less cost, in the larger sizes at least, than they can now be obtained from the bolt and nut manufacturers.

Plates Nos. 1, 2 and 3, showing the development of formula,

have been reissued, having corrections made in dimensions previously referred to as shown on plate No. 4-A. The corrected plates which accompany this report bear the numbers 1-A (not reproduced), 2-A, 3-A.

Several users of the castle nuts suggested drilling two cotter holes spaced 90 degrees in the larger bolts, for the reason that on the coarser threads 1/12th turn instead of 1/6th would be decidedly preferable. The committe decided not to make any recommendation on this point, preferring only to consider that feature of the bolt necessary to determine dimensions for the castle nut.

The committee would make the following recommendations, the dimensions for each of which is given in detail on plate No. 4-A, under the heading "Recommended Dimensions":

1. A series of castle nuts having U. S. standard thread with dimensions as shown.
2. A series of thin castle nuts having U. S. standard thread with dimensions as shown.
3. A series of special thin castle nuts having outward proportions the same as thin castle nuts, but having special number of U. S. threads, as shown.
4. Rough castle nuts to have diameter across the flats as shown. These dimensions correspond with U. S. standard dimensions for hexagon nuts. Finish of flats to be obtained by grinding and buffing, or by milling, the same practice as obtains with the U. S. standard nuts.
5. Finished nuts to have facing washer on bottom with dimension as shown. Rough nuts to have bottom corner slightly chamfered.
6. A series of standard cotter pins with dimensions as shown.
7. A series of Player cotter pins with dimensions as shown.
8. A series of taper pins with dimensions as shown.
9. Bolt ends projecting with cotter-pin hole location as shown.

Following the reading of the report the secretary presented a communication from W. L. Austin, a member of the committee, saying that he approved the report with the following exceptions:

1. The nuts should be U. S. standard in thickness, not more.
2. The threads should be turned off the outer end of the bolt, but the bolt should have a bearing of the full thickness of the nut in order to utilize all of the thread.
3. There should be but one style of cotter, namely, the common cotter pin.

John Player, a member of the committee, disagreed with the report in that on plate 3A the dimension H1 for the 1⅝ and 2¼ in. nuts should be minus 1-16 and H2 should be plus 1-16.

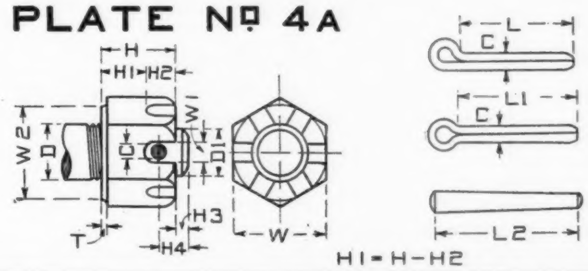
Discussion.—The report was given a very general and thorough discussion, and a motion by Mr. Wildin, which stated that the association accepted the committee's report as to thickness of the nut as a standard, was carried. Mr. Seley's motion that the cotter pin shown on plate 4A be accepted as a standard of the association was also carried.

An extended discussion was given to the matter of the number of threads for thin nuts and a motion by Mr. Wildin that the dimensions shown on Plate 4A, referring to the bolt and to special threads in the nut, be eliminated was defeated.

Action.—Mr. DeVoy's motion that the report as a whole be accepted and referred to letter ballot of the association for adoption as a standard was carried.

PLATE Nº 4A

TABLE OF DIMENSIONS FOR CASTLE NUTS AND THIN CASTLE NUTS



DIMENSIONS GIVEN ARE IN INCHES

RECOMMENDED DIMENSIONS

NUT	D	DIAMETER OF SCREW	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2
NUT		NO. OF THREADS PER INCH U. S. STANDARD CASTLE AND THIN CASTLE NUT	13	11	10	9	8	7	7	6	6	5 1/2	5	5	4 1/2	4 1/2	4	4	3 1/2	3 1/2	3 1/4
NUT		NO. OF THREADS PER INCH FOR SPECIAL THIN CASTLE NUT	13	11	10	9	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6
NUT	W	DIAMETER ACROSS FLATS ROUGH SIZE	7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8
NUT	W2	DIAMETER OF FACING COLLAR	13/16	1	1 3/16	1 3/8	1 9/16	1 3/4	1 15/16	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 7/16	3 13/16	4 3/16	4 9/16	4 15/16	5 5/16
NUT	T	THICKNESS OF FACING COLLAR	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
NUT	H	THICKNESS OF CASTLE NUT-ROUGH	13/16	15/16	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16	2	2 1/8	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16
NUT	H	THICKNESS OF CASTLE NUT-FINISHED	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	1 15/16	2 1/16	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 1/4
NUT	H	THICKNESS OF THIN CASTLE NUT-ROUGH	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 3/8	1 7/16	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16
NUT	H	THICKNESS OF THIN CASTLE NUT-FINISHED	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 5/16	1 3/8	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
NUT		NO. OF SLOTS IN CASTLE	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
NUT	W1	WIDTH OF SLOT IN CASTLE	1/4	1/4	1/4	5/16	5/16	3/8	3/8	3/8	3/8	3/8	7/16	7/16	7/16	7/16	9/16	9/16	5/8	5/8	5/8
NUT	H2	DEPTH OF SLOT IN CASTLE	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1/2	9/16	9/16	9/16	9/16	11/16	11/16	3/4	3/4	3/4
BOLT	C	DIAMETER OF COTTER PIN HOLE IN BOLT	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
BOLT	H3	PROJECTION OF BOLT BEYOND TOP OF NUT	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8
BOLT	D1	DIAMETER OF REDUCED END OF BOLT	3/8	7/16	9/16	11/16	13/16	7/8	1	1 1/8	1 1/4	1 5/16	1 7/16	1 9/16	1 11/16	1 7/8	2 1/8	2 5/16	2 9/16	2 3/4	3
BOLT	H2+H3	LENGTH OF REDUCED END OF BOLT	9/16	9/16	9/16	5/8	5/8	3/4	3/4	3/4	3/4	3/4	13/15	13/16	7/8	7/8	1	1	1 1/8	1 1/8	1 1/8
BOLT	H4	DISTANCE FROM CENTER OF COTTER PIN HOLE TO END OF BOLT	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1/2	9/16	9/16	5/8	5/8	11/16	11/16	13/16	13/16	13/16
COTTER	C	NOMINAL DIAMETER OF COTTER PIN	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
COTTER	L	LENGTH OF PLAYER COTTER PIN	7/8	1	1 1/4	1 1/2	1 1/2	1 3/4	1 3/4	2	2	2	2 1/2	2 1/2	3	3	3 1/2	3 1/2	4	5	5
COTTER	L1	LENGTH OF COMMON COTTER PIN	1 1/4	1 1/2	1 3/4	2	2	2 1/4	2 1/2	2 1/2	3	3	3 1/2	3 1/2	3 1/2	4	5	5	5	6	6
TAPER PIN	"	SIZE OF TAPER PIN USED IN PLACE OF COTTER	•2	•2	•2	•4	•4	•6	•6	•6	•6	•6	•6	•6	•7	•7	•8	•8	•9	•9	•9
TAPER PIN	L2	LENGTH OF TAPER PIN	1 1/4	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/4	3 1/2	3 3/4	4 1/4	4 1/2	5	5 1/4	5 3/4

WHAT PROGRESS HAS BEEN MADE IN LUBRICATING MATERIAL ECONOMIES.

Committee:—T. S. Lloyd, Chairman; E. D. Bronner, E. F. Needham, T. Roope, G. J. DeVilbiss.

[The nature of the report submitted by the committee was essentially one of the comparison of earlier-day methods with present-day practices. It is summarized as follows.—ED.]

Great progress has been made in lubricating economies, and in summarizing factors conducing thereto the following are most prominent:

Designs of locomotives with features whereby lubricated parts have been made readily accessible.

More general use of types of valve gear with lubricated parts accessible, and further permitting easier access to other lubricated parts.

Improved construction and location of lubricators and piping, namely, locating all lubricators where feed can be readily observed, both day and night by enginemen, high enough that all oil delivery pipes have gradual fall from lubricator to steam chest or point of delivery.

Close attention to choke plugs.

Careful attention to material entering into the construction of journals and bearings, and condition thereof.

The use of grease for lubrication of crank pins and driving-box journal bearings.

The adoption of proper devices and methods for the use of greases.

Improved method of packing engine trucks, trailers, oil-lubricated driving journal cellars and tank-journal boxes with properly saturated waste.

Improved storage and measuring facilities for oil.

Careful attention to renovating and reusing prepared packing and greases.

Uniformity in accounting, etc.

The report of this committee, which is given in abstract above, did not receive any extended discussion. The committee was continued for another year.

SAFETY VALVES.

The report of the committee on the size and capacity of safety valves for use on locomotives stated that owing to the financial condition during the past year no experimental work had been done and requested that the committee be continued to complete its work. There was no discussion on this subject and the committee was continued.

TOPICAL DISCUSSIONS.

Brick Arches and Water Tubes in Locomotive Fire Boxes.—This subject was opened by Mr. Walsh (C. & O.), who stated that not only was the arch itself a very desirable feature, but the increased heating surface and the circulation afforded by the water tubes added materially to the steaming qualities of the engine. He was most decidedly in favor of brick arches and reported that about 20 lbs. of coal per mile could be saved on one class of engine on one of his divisions by the application of the brick arch. The cost of the arch would be saved in one round trip of the engine. Arches were found to last from two to six weeks in large locomotives.

Prof. Hibbard drew attention to the desirabiilty of obtaining tough in preference to high-temperature fire brick. President Vaughan stated that he had found the application of arches to be a matter of conditions. They were of great value in some districts and of no value in others.

Mr. Parish stated that practically all locomotives on the Lake Shore were equipped with brick arches, including switch engines, and that the saving obtained in this way was very large.

Mr. Manchester stated that it had been the practice on the Milwaukee for twenty years to use a brick arch. They were firmly convinced that it was the most desirable thing.

Is Previous Railway Experience of Advantage to Locomotive Firemen?—D. R. MacBain (N. Y. C.) opened this subject and summed up his remarks as follows:

1. Should it be the good fortune of a road to get men who have fired elsewhere and been laid off on account of reduction in force, the experience they have had ought to be of some value to the employing company. Thy have, as a rule, the advantage of being young men, which is a desirable feature.

2. If intelligent young men could be induced to enter the track, bridge, car repair and freight house gangs with a prospect of advancement to the locomotive service, if they can qualify, it would seem that the scheme ought to work out advantageously to the railway companies.

3. In our opinion the next best material from which to choose firemen is from the farm. The farmer's son, after he is broken in, is usually appreciative of his position and will develop into a good, reliable locomotive fireman.

Much can be accomplished toward improving efficiency among locomotive firemen by having good men as firemen's instructors who shall have no other duties to perform and who can apply their whole mental and physical energy toward instruction.

Is the Additional Cost of Flexible Staybolts Justifiable?—H. D. Brown (Erie) in opening this subject stated that he had written to a number of the members for their experience in this matter and had found to his great surprise that all of the answers agreed with his own opinion that this cost was justifiable. He suggested that a committee be appointed to determine the best method for proper adjustment of flexible staybolts, who should also make experiments to determine the exact amount and location of expansion in the fire box.

Mr. Bentley thought the application of flexible staybolts should be based on the number of staybolt breakages, and where there was a small staybolt breakage the use of the flexible bolt would be unnecessary. He stated that one of their engines gave them trouble, but by redesigning the fire box, so as to get longer staybolts, it had been practically eliminated.

Mr. DeVoy drew attention to the possible value of flexible staybolts in reducing cracked side sheets. He was of the opinion that by applying flexible staybolts in the proper places trouble with cracked sheets could be eliminated.

Is the Usual Front Row of Crown Bolts in a Locomotive Boiler Beneficial or Otherwise?—M. Seley, in opening this discussion, read a report, which was prepared by one of his subordinates, to the effect that the flexible crown stays in the front end of a fire box were not of any value.

Geo. F. Fowler drew attention to some experiments which had been made a long time ago by Mr. Eddy on the Fitchburg Railway, for determining the movement at the front end of the crown sheet. He found that in getting up steam the front end of the crown sheet actually lifted as the water became hot, and this was followed, after pressure had been generated in the boiler, by a downward movement, bringing it back to the same location as it was when the boiler was cold.

Mr. Fuller explained the fact that the crown sheet was often ¼ of an inch below the top of the flue sheet just back of the flange, the flange being bent down in the same manner, by stating that this was due to the constant rolling of the flues and the consequent stretching of the flue sheets.

Are By-Pass Valves Necessary on Piston Valve Locomotives?—Mr. Bentley, in opening this subject, spoke as follows:

"When piston valves were first used on locomotives it was very naturally supposed that, on account of the shape of the valve and its inability to lift as a slide valve does, it was necessary to have some arrangement or by-pass that would take care of a higher pressure in the cylinder, due to compression, than the steam pressure carried in the boiler, and numerous devices were used, all having the same object in view, but each design differing somewhat in the manner of operation.

"In one of the valves tested it required over 200 lbs. above boiler pressure to operate, and therefore was practically useless. Others performed their function satisfactorily, while they remained intact, but the hammering they were subjected to caused them to break, which resulted in a bad steam leak that was often difficult to locate.

"A double-seated valve gave considerable trouble on this account. The seat closing the steam from the atmosphere would be tight, while the other, separating steam chest and cylinder pressure, would not close, owing to the expansion of the metal, and a continuous blow would take place and much coal was wasted in this manner.

"After using various types for several years, with unsatisfactory results, we made a series of tests in September, 1907, and found that under ordinary service conditions the by-pass valves were unnecessary and therefore took them off. After running the engines without them for nearly two years, but having suction valves of ample capacity, we do not find any bad effects, neither have we had any more cylinder heads broken than we did before.

"Where by-pass valves are used simply to by-pass the air from one end of the cylinder to the other, when drifting, they may give satisfactory results, and probably will be better than the suction valve located outside, as the air will pass back and forth from one end of the cylinder to the other and not through the walls of cylinder to the extent it would do if drawn in through regular suction valves from outside.

"With water in the cylinders the by-pass or cylinder relief valve might give some relief, but under ordinary running conditions we find no advantage.

"While at a locomotive builder's recently, in talking about some proposed engines having 25 in. by 32-in. cylinders and a boiler pressure of 170 lbs. without a superheater, it was the opinion of their engineering department that a by-pass valve would be necessary, probably on account of the greater condensation that would occur in the cylinder of the sizes given,

and using a comparatively low boiler pressure without a superheater. But for engines having ample steam space, using good water, and with cylinders suited for a boiler pressure of 190 to 225 lbs., we do not believe a by-pass valve necessary."

In answer to questions he stated that there had been no difference noticed in the loosening of valve heads, or the breaking of valve bushings or valve packing rings. This was on inside admission piston valve engines. The earlier trouble with broken packing rings had been overcome by the substitution of a T ring for the rectangular ring.

President Vaughan called attention to the fact that there is **a wide difference between putting a by-pass valve on and saying that you are using it and in having it used, as it has been found that many of these valves are blanked by the engineers and roundhouse forces on account of various personal objections.**

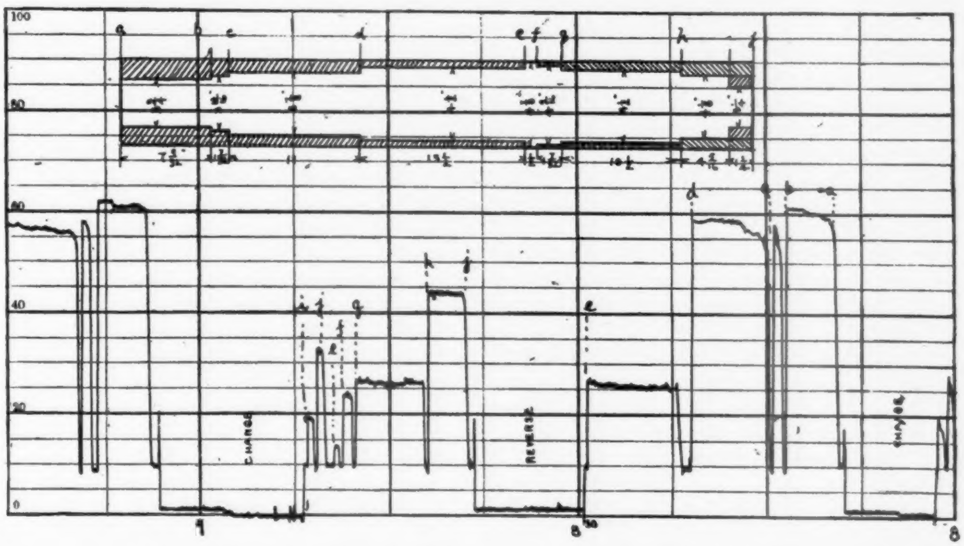
GRAPHIC RECORDING WATTMETER.

With the help of electrical apparatus it is possible to obtain from any motor-driven machine tool a complete graphic record of exactly what the machine is doing. In the case of a planer, for instance, every stroke may be clearly seen on the record, and with any tool every stop for change of work or other cause, every adjustment of a tool, may be observed and the length of time for each shown at a glance. In addition the amount of power required to do any given piece of work may be determined with accuracy. These records may be obtained by the use of a Westinghouse curve-drawing instrument in connection with individual motors driving machine tools.

The meter consists of a pen, instead of the usual indicating needle, arranged to deflect over a scale. Under this pen is a large roll of specially graduated paper moved by clockwork, the usual speed being 8 inches an hour. The pen produces a fine mark on the paper, its length above the zero line showing the power consumed by the motor. A typical record, very much reduced, is shown, illustrating the operation of roughing out a motor shaft on a Lodge & Shipley lathe. The curve is read from right to left, with zero at the bottom. The outline of the shaft worked on is shown also; the lettering on the shaft and the record correspond. With such a curve any foreman, superintendent or other person interested in investigating the actual working conditions of the shop, can have exact records of any or all operations which he desires to consider.

At 8 o'clock the workman was just completing a shaft and then shut his motor down in the interval marked "change" to take out the completed shaft and put a new one in about 8.10 o'clock. Work was begun on the new shaft by starting the motor and cutting from *a* to *b*. For about a minute after starting, the motor ran light while the workman was getting his tool ready, but the power speedily increased showing a heavy cut was being taken. At *b* the diameter changed and the cutting was stopped momentarily, as shown by the drop in the curve, to readjust the tool. Cutting began again and continued to *c*, but the power required was less because of a smaller amount of metal being removed. At *c* the diameter changed and the tool was adjusted to make the cut from *c* to *d*, which was evidently taken at a faster speed as the power was nearly as high as when cutting from *a* to *b*, though the cut was somewhat lighter. At 8.30 the motor was shut down for the interval marked "reverse," in which the shaft, half completed, was taken out and reversed in position in order to cut from *j* to *e*. the interval during which the motor took no current, from 8.30 to 8.39, shows that 9 minutes were required to reverse the shaft. After reversal the cutting began at *j* at the right hand end of the shaft, while, of course, the record continues from the point where cutting ceased, continuing always from right to left. The lettering on the shaft and the record correspond, so that there is no possibility of confusion. The motor was finally shut down at 8.52, when the work on the shaft was completed. During the interval from 8.52 to 9.03, marked "change," the completed shaft was removed and a new one placed in position, when the cycle of operations was begun again.

As an example of a saving which the use of these meters produced by indicating a source of delay the following case may be noted: A comparison of records obtained from lathes which were roughing out motor shafts showed that in one there were stops averaging five minutes each while the shaft was being taken out and a new one put in, or a shaft half completed was being reversed in position; in the other the delays averaged 10 minutes, just twice as long. Naturally some explanation of this discrepancy was looked for. It was found that the shorter time for changes and reversals occurred on a shaft small enough to be handled entirely by hand, but the other shaft was so heavy as to require the services of a crane in handling. The delays were due to the impossibility of obtaining the overhead traveling crane at once. To remedy this defect a jib hoist was installed beside the lathe and the material was handled in and out of the lathe by it. The result was a saving of 10 minutes on the time of each shaft which meant the completion of two more shafts a day.



GRAPHICAL RECORD OF POWER REQUIRED BY A LATHE IN TURNING A MOTOR SHAFT.

BUSINESS FAILURES THIS YEAR.—There have been fewer business failures for the first six months of this year than for the same period in 1908. R. G. Dun & Co. report 6,831 failures, with liabilities of $88,541,373, since January 1, as compared with 8,709 failures and $124,374,833 in the first half of 1908. Bradstreet's figures make the number of failures so far this year 6,149, with liabilities amounting to $80,651,976, compared with 7,562 failures having $178,782,769 liabilities, during the first six months of 1908.

MASTER CAR BUILDERS' ASSOCIATION

(*Continued from page 298.*)

CAR WHEELS.

Committee: Wm. Garstang, Chairman; W. C. A. Henry, A. E. Manchester, R. L. Ettenger, O. C. Cromwell, W. E. Fowler, R. F. McKenna.

Since the 1908 convention the scope of this committee has been largely increased and now includes in its work "steel and steel-tired wheels" in addition to cast-iron wheels. As a consequence, the personnel, also the name of the committee, have been altered and under its new title, "Standing Committee on Car Wheels," will include in its recommendations in this report subject matter referring to cast-iron, solid-steel and steel-tired wheels intended for service under both passenger and freight equipment cars and will deal with each separately, and will also deal with points that have been raised by the different railway administrations through the executive committee, as well as points in reference to the text of subject matter now appearing in the 1908 Proceedings of the Association and the Code of Interchange Rules of 1908 issue which the committee themselves have found to conflict.

ARTICLE 1. As a prelude, a recapitulation of the points raised in the 1908 report is apropos, as it will be remembered that a minority report was presented by one member of the committee, and as a result the entire report was recommitted. The 1908 report included a "Wheel Defect and Worn Coupler Limit Gauge," having two slots for gauging worn flanges, one slot being 1 1-16 inches wide and the other slot 1 inch wide, and the committee, after further investigation, accepts the modification proposed in which these slots are made respectively 1 inch and 15-16 inch wide and endorses as correct the wheel defect and worn coupler limit gauge now appearing on page 7 of the 1908 Code of Interchange Rules, and the cuts showing the method of using it, as shown on pages 10, 11 and 12 of the same issue.

ART. 2. The shape of brackets or ribs on cast-iron wheels in the report for 1908 was altered from the long radius type to a short radius type, the curve of the brackets being made such that the outer end of the bracket would flow into the rim at the back of the flange in a line following the circumference of the wheel, the bracket originating on the double plate portion in a line radial to the center of the hub. This shape of bracket has been adhered to for the promotion of good foundry practice and to prevent unequal construction strains, and the drawings presented by the committee in connection with this report include brackets of this form.

ART. 3. The question of regulation of foundry practice in the manufacture of cast-iron wheels to promote uniformity of product in the different sections of this country, also the question of proper chemical analysis for materials entering into these wheels, has during the past year received a full share of the attention of the committee working jointly with a committee representing the Association of Manufacturers of Chilled Car Wheels, which association, during the year 1908, was regularly incorporated and is empowered to act for the wheelmakers who are members of the association.

The result of the conference on the regulation of foundry practice and chemical analysis phases has in no wise settled the subject, and this committee has, at the solicitation of the wheelmakers' committee, agreed that the study thus far has not been sufficient to permit the formation of a recommendation, and we, therefore, report progress on this portion of the work and ask another year's consideration before submitting any definite recommendations. We submit, as an appendix (not reproduced here), extracts from the "Record of Proceedings of the Association of Manufacturers of Chilled Car Wheels," submitted to the committee, which deals with the subject from the view-point of the manufacturers, and the items contained therein will be taken up and dealt with later in accordance with the conclusions reached by this committee.

ART. 4. From the convention of 1908 to and including the present time, the committee has directed its attention to instructions received from the executive committee, namely:

(a) To prepare drawings showing the limit of wear of solid-rolled steel wheels in connection with the minimum thickness for steel tires shown on Sheet M. C. B.—A.

(b) To confer with similar committees from the Master Mechanics' and Maintenance of Way Association on the widening of the gauge on curves, owing to the fact that the minimum tread of car wheels has an important bearing on this subject.

(c) To confer with the committee of the American Railway Engineering and Maintenance of Way Association regarding the allowable length of flat spots on car wheels in connection with the effect such defects produce on bridges and track, and to report back to the executive committee regarding the procurement of apparatus for making tests.

ART. 5. The committee's attention has been called to corrections necessary in the M. C. B. specifications for cast-iron wheels relating to the form of chills, weights of wheels, and the necessity of casting the initials of the railroad or private line company on all wheels used in interchange service, and has also been directed to a necessary change in the form of the double plate portion of the 60,000 pounds capacity wheel from that now shown in the 1908 Proceedings, to insure sounder wheels than are now produced from the drawings for this wheel.

ART. 6. Considerable comment has been directed against the slight taper at the sand rim in the present tread contour on account of "chipped rims"; also evidence has been presented showing that a greater mileage could be secured from all wheels if the sand rim taper was increased and lengthened toward the flange, and that further freedom from broken flanges would result if the height of the flange "when new" was reduced, owing to the fact that shorter flanges would not be as apt to strike fillers in the track, when a wheel having a tread worn hollow passed over a frog where the head of the rail had been worn down considerably.

ART. 7. Attention has also been directed to subject matter pertaining to gauges, also the text in the Standards and Recommended Practice now appearing in the Proceedings and in the Rules of Interchange, all of which must be corrected to prevent conflict and will be dealt with in the recommendations contained in this report.

ART. 8. Consistent action on the part of the committee, in view of the fact that its 1908 report was recommitted, will be to condense the 1908 report and the report for 1909 into one and present them at the 1909 convention, and the conclusions of the committee on all points involved for both years appear in the following recommendations:

RECOMMENDATIONS

IN REFERENCE TO CAST-IRON WHEELS COVERING POINTS REFERRED TO IN ARTICLES 2, 5 AND 6.

1. The cancellation of the present cut covering the 33-inch, 600-pound wheel now appearing on M. C. B. Sheet "J" of Recommended Practice in 1908 Proceedings, and the substitution of a cut reduced from that shown in Fig. 1, covering the entire new form of 625-pound wheel for use under 60,000 pounds capacity cars.

2. The cancellation of the present cut covering the 33-inch, 650-pound wheel now appearing on M. C. B. Sheet "J" of Recommended Practice in 1908 Proceedings, and the substitution of a cut reduced from that shown in Fig. 2, for 675-pound wheel, which covers the present form through the hub, double-plate and single-plate parts, with the new form of tread and flange and curve of brackets added.

3. The cancellation of present cut covering 33-inch, 700-pound wheel now appearing on M. C. B. Sheet "J" of Recommended Practice in 1908 Proceedings, and the substitution of a cut reduced from that shown in Fig. 2 for 725-pound wheel, which covers the present form through the hub, double-plate and single-plate parts, with the new form of tread and flange and curve of brackets added.

4. The cancellation of cuts covering wheel tread now appearing on Sheets 7 and 12 of M. C. B. Standards in the 1908 Proceedings and the substitution of a cut reduced from that shown in Fig. 4 to appear as M. C. B. Sheet 12.

5. The cancellation of cuts covering "Maximum Flange Thickness Gauge" and "Minimum Flange Thickness Gauge" now appearing on Sheet 12 of M. C. B. Standards in 1908 Proceedings and the substitution of cuts shown in Figs. 5 and 6, which have been revised to show the new flange and tread contour proposed in this report.

6. The cancellation of cut showing "Wheel Defect and Worn Coupler Limit Gauge" now appearing on Sheet 12 of M. C. B. Standards and the substitution of a cut, Fig. 7, to appear on M. C. B. Sheet 12. The necessity for such change is referred to in Article 1.

7. The cancellation of the cuts showing "Terms and Gauging Points for Wheels and Track, Standard Reference Gauge for Mounting and Inspecting Wheels, Wheel Check Gauge, Guard Rail and Frog Wing Gauge, and Standard Reference Gauge for Mounting and Inspecting Wheels (as used for inspecting)," and the substitution therefor of cuts of the same gauges shown in Fig. 8. This is imperatively necessary on account of an error of 1-64 inch shown in a main dimension in the original drawings for these gauges and which made corrections necessary in several

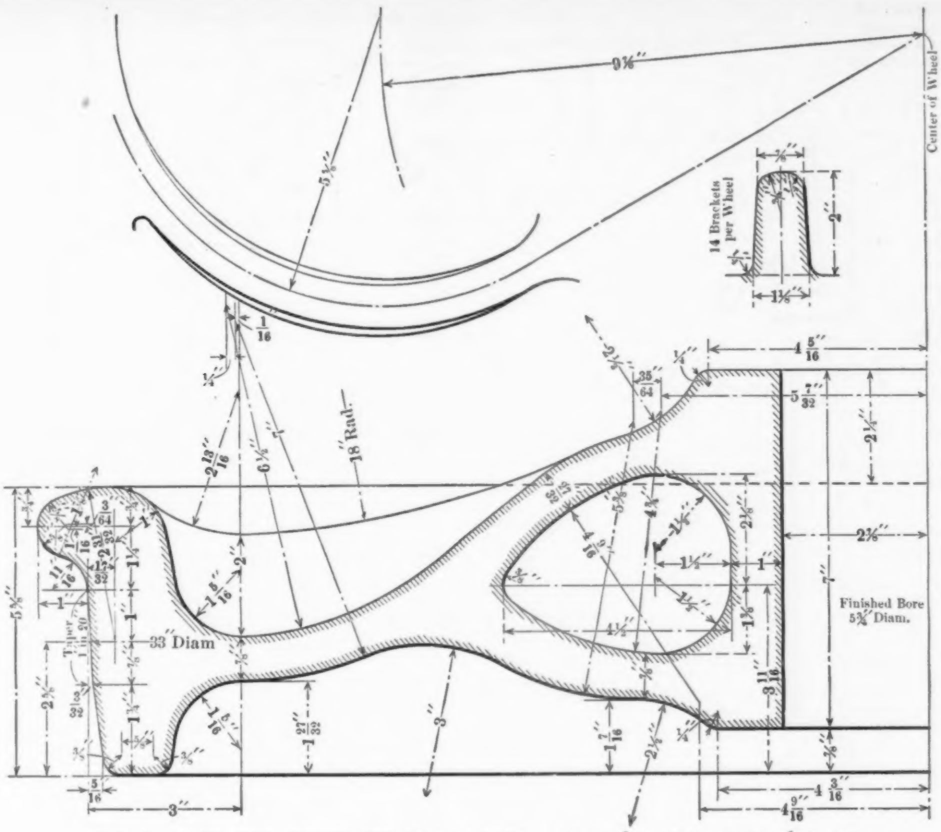
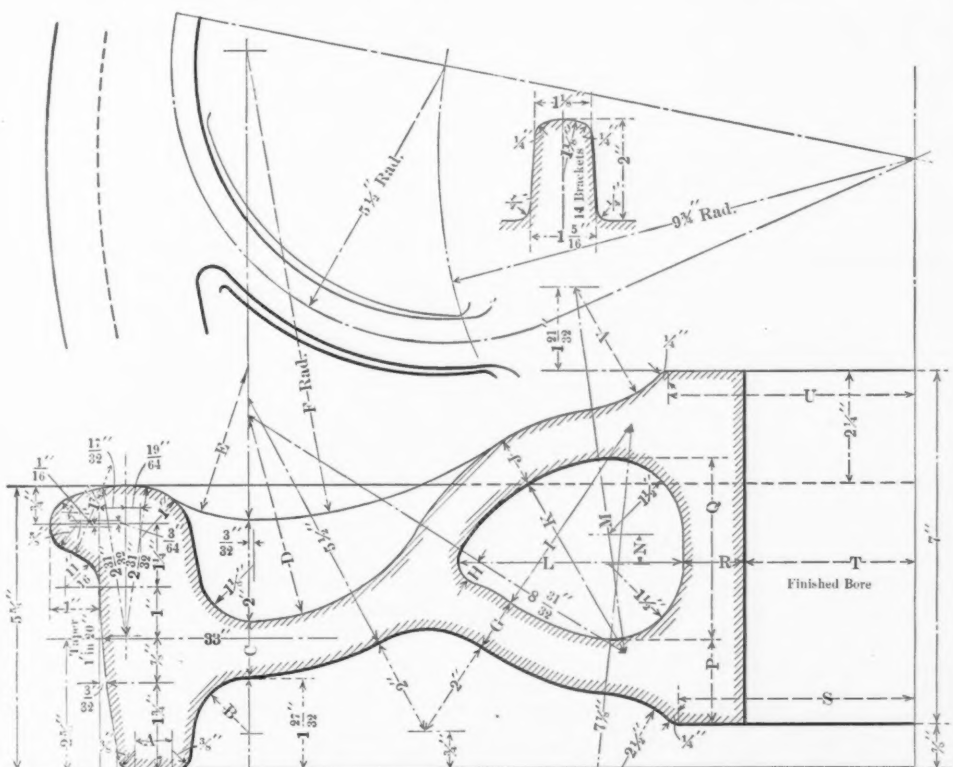


FIG. 1.—CAST IRON WHEEL FOR 30-TON CARS. MAX., 625 LBS. MIN., 615 LBS.



	80,000※	100,000※		80,000※	100,000※		80,000※	100,000※		80,000※	100,000※
A	$\frac{11}{16}''$	¾″	G	$\frac{15}{16}''$	$1\frac{1}{16}''$	M	7⅜″	$7\frac{11}{32}''$	S	$4\frac{11}{16}''$	4½″
B	$1\frac{3}{16}''$	1⅛″	H	⅝″	$\frac{13}{32}''$	N	¾″	$\frac{9}{16}''$	T	3¼″	3½″
C	1″	$1\frac{3}{32}''$	I	$4\frac{7}{16}''$	$4\frac{5}{16}''$	O	$1\frac{1}{32}''$	1″	U	$4\frac{13}{16}''$	$5\frac{1}{16}''$
D	$4\frac{3}{32}''$	$4\frac{1}{16}''$	J	⅞″	1″	P	1½″	$1\frac{11}{16}''$	V	$2\frac{3}{16}''$	$2\frac{7}{16}''$
E	$2\frac{7}{16}''$	3″	K	$3\frac{15}{16}''$	$3\frac{29}{32}''$	Q	3¾″	$3\frac{9}{16}''$			
F	9½″	9¼″	L	$4\frac{61}{64}''$	$4\frac{9}{16}''$	R	1⅛″	1¼″			

FIG. 2.—CAST IRON WHEELS FOR 40 AND 50-TON CARS. MAX., 675 AND 725 LBS.; MIN., 665 AND 715 LBS., RESPECTIVELY.

sub-dimensions. It is also necessary on account of a reversal of the words "Inspection" and "Mounting" in regard to the use of the Standard Reference Gauge.

8. The cancellation of the "Specification for 33-inch Cast-iron Wheels" now appearing on pages 658, 659 and 660 of the M. C. B. Standards of the 1908 Proceedings, and the substitution of the revised specifications attached to this report, which have been corrected in reference to all points appearing in Article 5. (Not reproduced.)

9. The correction of the "Text" in the Standards and Recommended Practice now appearing in the Proceedings and referred to in Article 7 is as follows. (See page 635, 1908 Proceedings.)

Entry No. 4. To be corrected to read as follows:

INSIDE GAUGE OF FLANGES is the distance between backs of flanges of a pair of mounted wheels measured on the base line.

Entry No. 5. GAUGE OF WHEELS is the distance between the outside faces of flanges of a pair of mounted wheels measured on a line parallel to the base line, but ⅝ inch farther from the axis of the wheels.

The dimensions in the wheel gauge distances given are correct with the exception of that now shown for the THICKNESS OF FLANGE. This should be corrected to read 1 15-64 inches.

RECOMMENDATIONS

IN REFERENCE TO CODE OF RULES GOVERNING INTERCHANGE OF TRAFFIC.

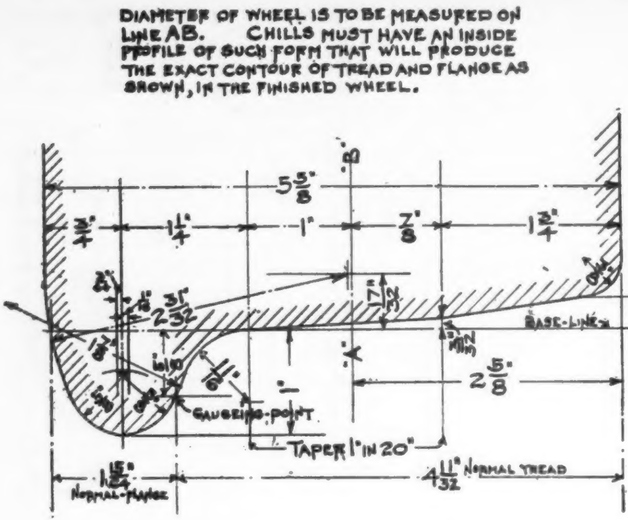
A revised "Form of Bill" covering wheels removed and applied is presented, and it is proposed that this convention adopt the revised form as a standard, replacing the form now appearing on pages 496 of the 1908 Proceedings and 39 of the Code of Interchange Rules. The alterations appear at the 5th and 11th columns (from the left side) and consist in adding these columns covering "Railway Company's Initials or Name on Wheel," instead of omitting this information as per present form.

Rule 17 to be corrected to read as follows: Wheels loose or out of gauge (see Fig. 6), for wheels cast prior to the M. C. B. Standard Tread and Flange adopted in 1907, or (Fig. 6-A) for wheels cast after January 1, 1908.

Rule 21, in the Code of Interchange Rules, refers to Figs. 2 and 2-A, the Fig. 2 representing the Maximum Flange Thickness Gauge for wheels cast prior to the M. C. B. Standard Tread and Flange adopted in 1907, and the Fig. 2-A representing the Maximum Flange Thickness for wheels cast after January 1, 1908, ***but the Rule does not so state,*** and the committee proposes that the Rule shall be revised to read:

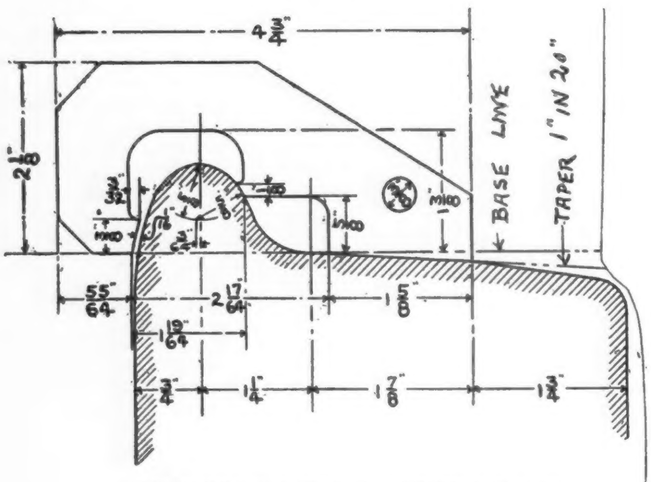
"The determination of flat spots, worn flanges and chipped treads shall be made by gauge, as is shown in Fig. 1.

"The determination of thick flanges for all wheels cast prior to the M. C. B. Standard Tread and Flange adopted in 1907, shall be made by a gauge shown as Fig. 2, and for all wheels cast after January 1, 1908, shall be made by a gauge shown as Fig. 2-A."



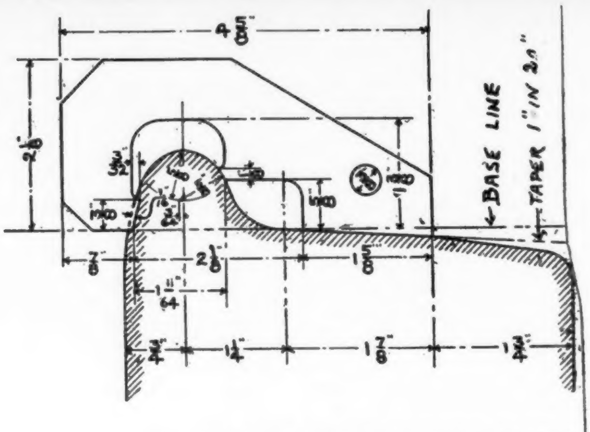
WHEEL TREAD AND FLANGE FOR CAST IRON WHEELS

FIG. 4.



MAXIMUM FLANGE THICKNESS GAUGE.

FIG. 5.



MINIMUM FLANGE THICKNESS GAUGE.

FIG. 6.

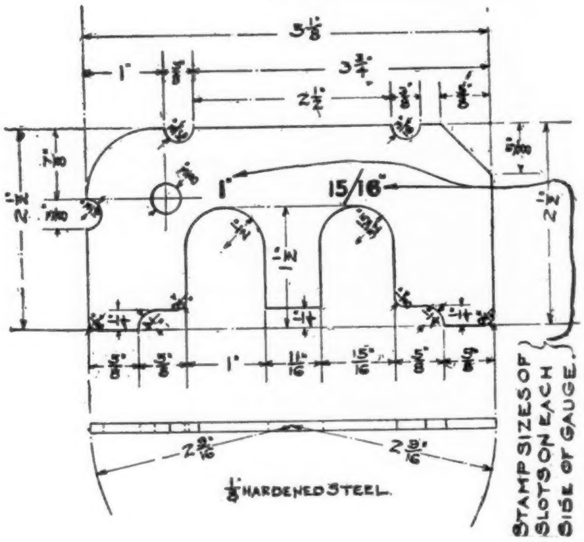
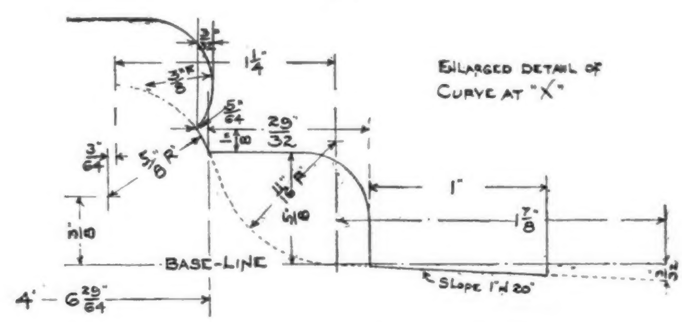


FIG. 7.



SEE FIG. 8.

From advice presented to the committee it is evident that the gauge for detecting worn flanges is not being properly used, and Fig. 4, pages 478 of the 1908 Proceedings and 10 of the Code of Interchange Rules, should have the following added to protect against improper use, namely:

"This gauge must always be held in horizontal position and have the lip at the end of the gauge bearing on the tread when being used."

RECOMMENDATIONS

IN REFERENCE TO MOUNTING NEW CAST-IRON WHEELS; TO PROVIDE PROPER CLEARANCE WHEN PASSING THROUGH TRACK FROGS AND AT GUARD RAILS HAVING 1¾-INCH WIDTH OF FLANGE WAY.

Mechanical difficulties in the manufacture of cast-iron wheels require a variation of 1-16 inch in thickness, over or under the normal size for flanges, and as this is permitted under M. C. B. Rules, it was requested at a joint conference of this committee with the committee representing the American Railway Engineering and Maintenance of Way Association that a similar amount of latitude in reference to track construction be recognized, and after a thorough discussion of the subject from all standpoints it was agreed to recommend to the M. C. B. Association that a rule be formulated prohibiting the mounting of two wheels having maximum thick flanges on the same axle; therefore we propose that the M. C. B. Association adopt the following as a standard rule governing interchange of traffic.

Rule 66-A.

In no case may two new wheels having maximum thick flanges be mounted on the same axle.

Wheel check gauge, now appearing on page 682 of the 1908 Proceedings in connection with the paragraph covering the "Mounting of Wheels," is incorrect, and the cut now shown should be replaced by cut of wheel check gauge (Fig. 8) presented with this report.

CONCLUSIONS AND RECOMMENDATIONS

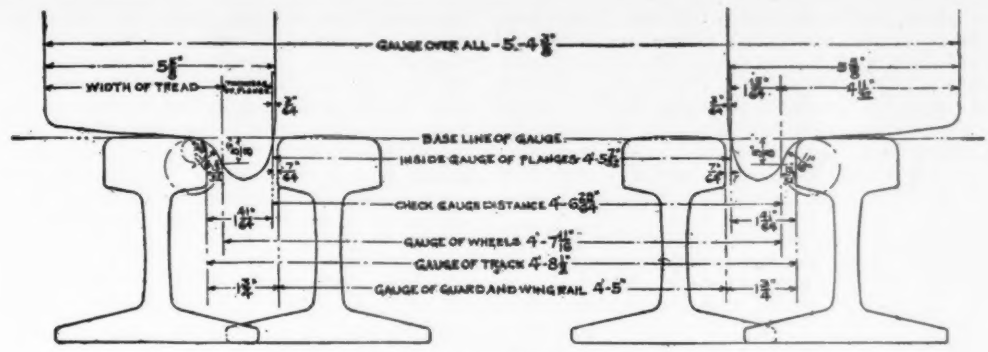
RELATING TO STEEL AND STEEL-TIRED WHEELS FOR FREIGHT AND PASSENGER CARS REFERRED TO IN ARTICLES 4 AND 7.

See Article 4, Executive Committee's Instructions (a).

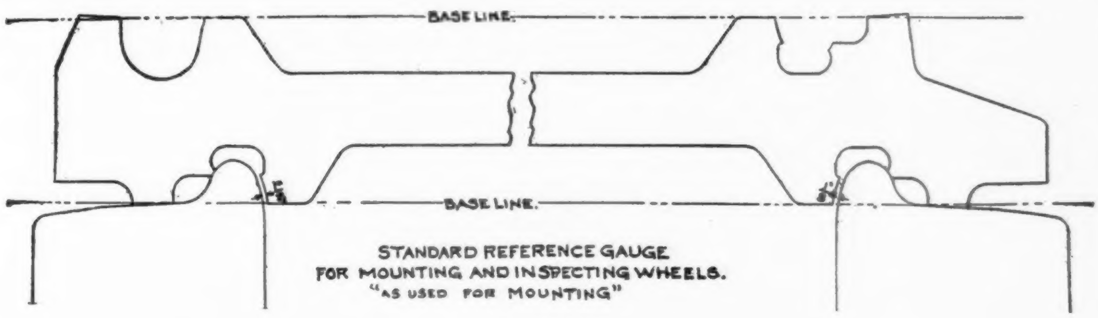
The committee has prepared and presents Fig. 9, covering limits of wear for steel and steel-tired wheels under both passenger and freight cars, and recommends that it be adopted as Recommended Practice governing the service operation of such wheels under both passenger and freight cars, and that the cuts now appearing on M. C. B. Sheet "A" of Recommended Practice and pages 529 and 530 of the 1908 Procedings, and 95, 96 and 97 of the Code of Interchange Rules be cancelled, and the four cuts on Fig. 9 be substituted therefor.

Location of limit of wear groove to be ¼ inch below the tread face on steel and steel-tired car wheels, when they have worn to condemning limit of wear. The shape of the groove to be as shown on these figures, and measurements to be taken from the horizontal or inside edge of same.

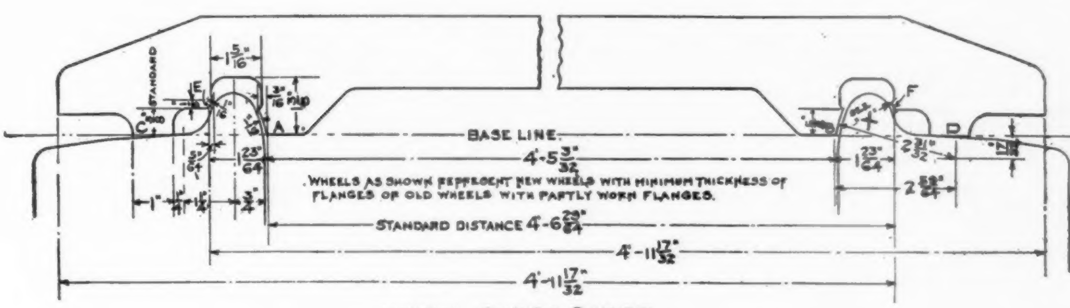
Existing M. C. B. Rules in Code of Interchange and referring to passenger cars require a removal of steel and steel-tired wheels "for worn flanges," when such flanges are greater in section than is prescribed for steel and steel-tired wheels when used under freight cars. Wheel loads under passenger cars will vary from 12,000 to 14,000 pounds and wheel loads under 80,000 pounds



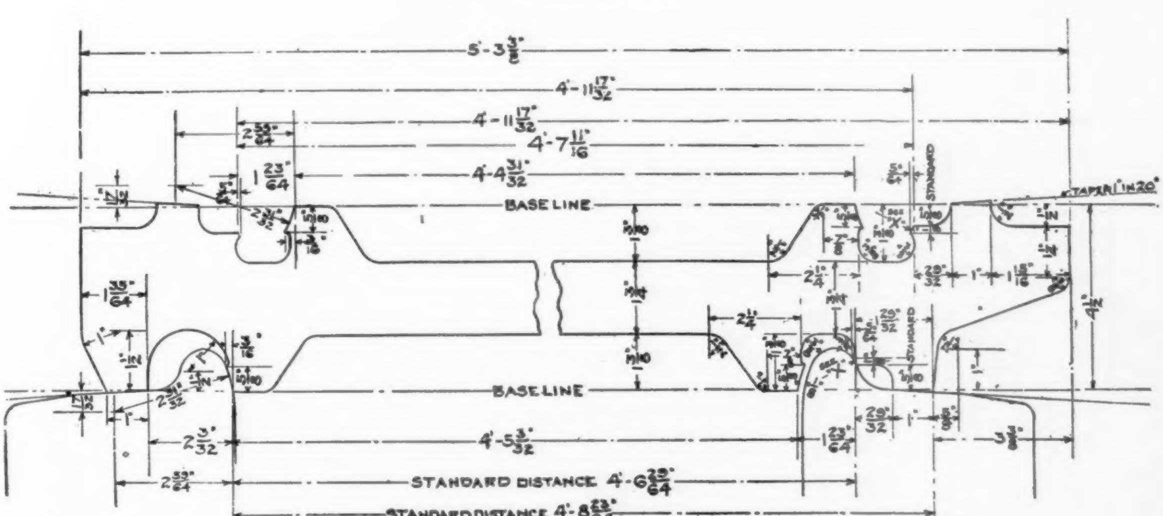
TERMS & GAUGEING POINTS FOR WHEELS AND TRACK.



STANDARD REFERENCE GAUGE FOR MOUNTING AND INSPECTING WHEELS. "AS USED FOR MOUNTING"



WHEEL CHECK GAUGE.



STANDARD REFERENCE GAUGE FOR MOUNTING AND INSPECTING WHEELS. "AS USED FOR INSPECTION"

FIG. 8.

capacity cars in freight service can, under M. C. B. Rules, be increased to 16,000 pounds and over, therefore, the committee propose that rules relating to worn flanges for passenger cars using cast-iron and steel-tired wheels be revised as follows:

RULE 14 (c).

Worn Flanges: Flanges having flat vertical surfaces extending more than 7/8 inch from tread, or flange less than 1 inch thick, gauged at a point 3/8 inch above tread.

Gauge: For condemning worn flanges of cast-iron wheels under passenger cars to be the same as is used for condemning worn flanges of cast-iron wheels under freight cars of 80,000 pounds capacity or over.

RULE 15 (b).

Worn Flange or Tire: With flange less than 15-16 inch thick or having flat vertical faces extending more than 1 inch from tread, or, with tire thinner than is shown in Fig. 9.

Gauge: For condemning worn flanges of steel and steel-tired wheels under passenger cars to be the same as is used for condemning worn flanges of steel and steel-tired wheels under freight cars.

The committee proposes and recommends that the "Tread and Flange Contour" for steel and steel tired wheels be revised as shown in Fig. 10, which is exactly similar to the new proposed tread and flange contour included in this report for cast-iron wheels, *from the point of the flange to the outside of the tread only*, and the development of the flange from the "point to the back face of the wheel or tire" has been made of such form that the same mounting and inspecting gauges used for cast iron wheels can be used for the new section of steel and steel-tired wheels.

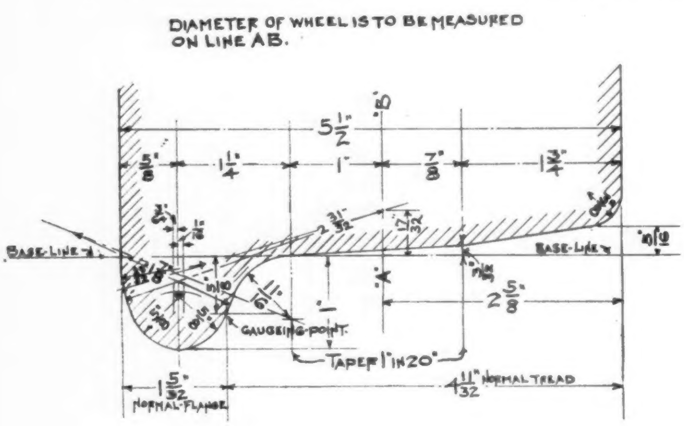
In conclusion, the committee's report on sections (b) and (c) of the instructions received from the Executive Committee is as follows: (See Article 4 for detail instructions.)

Section (b). The committee, working jointly with committees representing the Master Mechanics' and Maintenance of Way Associations, have not to date disposed of this, since the discussion at the single joint session was confined solely to *the width of flangeway in track through frogs and at guard rails*, and another meeting must be held with the representatives of the associations named to finally dispose of the subject.

Section (c). The committee, after working jointly with a committee representing the American Railway Engineering and Maintenance of Way Association, begs to report as follows:

No evidence has yet been presented showing that damage to bridges and track can be charged to flat spots on car wheels, whose lengths are within the limits prescribed by present M. C. B. Rules, and the committee, therefore, does not feel warranted in recommending to the Executive Committee that any expense be incurred for the procurement of apparatus for making tests.

Explanatory of the points raised in article 6, we beg to say the lengthening of the sand rim taper by moving the starting point of this taper closer to the flange, also the increase of the slope of the



WHEEL TREAD AND FLANGE FOR STEEL AND STEEL-TIRED WHEELS

FIG. 10.

tread at the sand rim will assist in reducing the number of chipped rims and will materially aid in increasing the mileage of all wheels before the tread becomes worn hollow, since it brings the starting point of the said rim taper within the zone of rail wear, and the starting point becomes gradually effaced from its original position and moves toward the rim of the wheel or downward on the sand rim taper, thus retarding the formation of a double flanged or worn hollow tread. The points in favor of the reduction of the height of flange for all wheels are two, namely: Flange condemned on account of being worn vertical on wheels having a 1-inch height of flange, will give a greater mileage before reaching this condemning limit on account of the flattening at the point of the flange in the proposed design and by reason of the shorter original height, will be less liable to strike filling blocks in track at crossings, frogs and switches when a wheel having the tread worn comparatively hollow passes over rails which have worn down considerably, and the committee feels that a reduction in the height of the flange can consistently be made when it is shown that the original angle of the flange to resist derailment is in no wise changed.

Recommendations presented to the Committee on Standards and Recommended Practice and referred to the Standing Committee on Car Wheels, contained several suggestions, all of which have been acted upon by this committee, with the exception of the following, which refers to "Reference Gauge for Mounting and Inspecting Wheels, and Check Gauge," page 636, M. C. B. Sheet 12, and is reported by the Pennsylvania Railroad Company with the suggestion "That the so-called reference gauge for mounting and inspecting wheels be dropped from standard practice and a gauge similar to print attached (not reproduced), be introduced for mounting of wheels; also a check gauge similar to print (not reproduced) attached, be introduced, which latter gauge is at the same time to be used by inspectors in yards and terminals." In the opinion of the committee, the gauge shown is a modified and improved form of check gauge that can be endorsed by the committee for use by all railroad companies who care to go to the expense entailed in the first cost of such gauge and we feel that the adoption of this form should be left to the individual members, as the points controlled by this gauge are exactly similar to those controlled by the present M. C. B. Standard Gauge, and the improvement consists in reversible hardened steel bearing points at contact with the gauging point on the flange. The check gauge shown has been arranged to govern the mounting of new wheels, also the remounting of partly worn wheels *centrally*

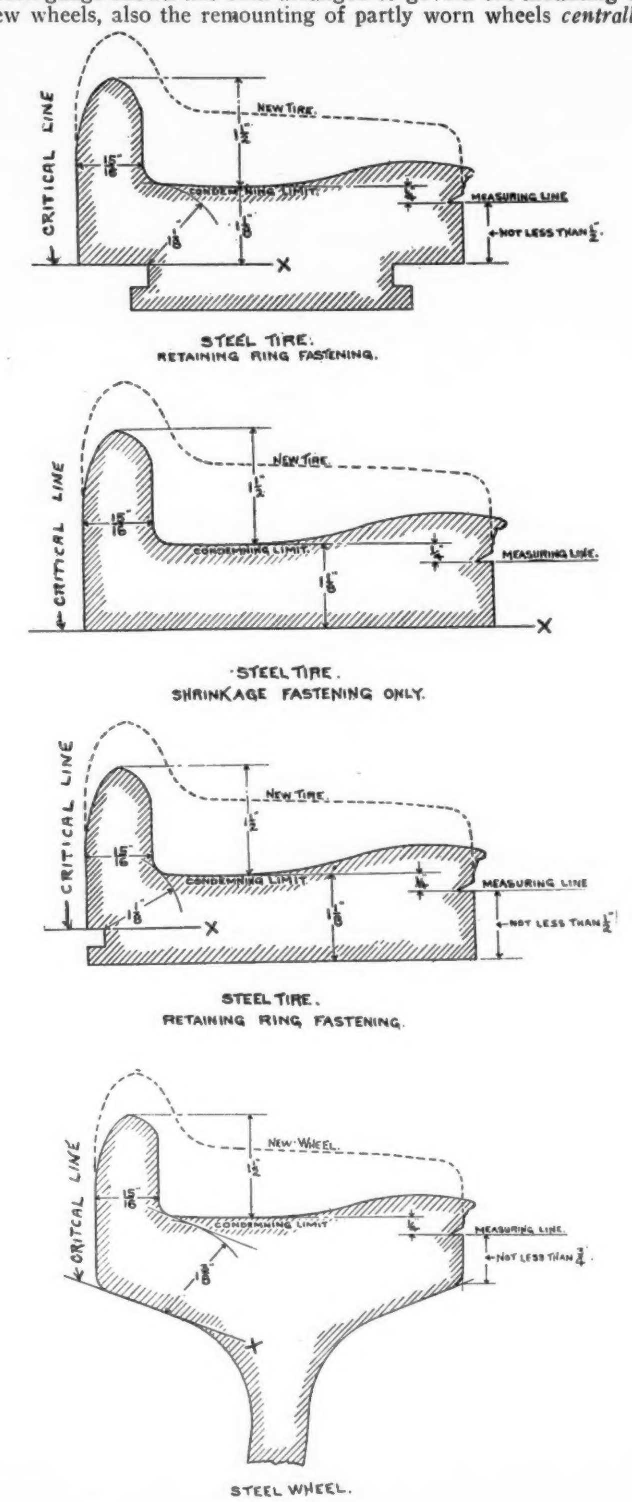


FIG. 9.

on one axle, and the design of the gauge is such that all axles, whether new or second-hand, must be provided, with a center-punch-mark in the middle of the axle, or equi-distant from the center of each journal. It is largely customary in railroad and contract shops to mount the first wheel on the axle gauging from the outside face of the collar, and then mount the mate wheel with the mounting gauge to the gauging points. At the solicitation of this committee, the M. C. B. Association several years since cancelled the use of a gauge designed for a similar purpose to that now proposed by the Pennsylvania Railroad, and the committee therefore does not feel warranted in recommending a gauge of the type proposed at this writing, preferring to leave the latter to the action of the convention.

The first, second and third recommendations, in reference to cast-iron wheels, are to govern the construction of all new patterns, chills, etc., for wheels made after the date this report and its recommendations are adopted, and are also to govern the construction of all patterns, chills, etc., that may be classed as renewals, from the same date, it being understood that all existing patterns and chills for wheels conforming to M. C. B. Standards in effect prior to this report may be used by the manufacturers until worn out in the regular course of business, at which time they shall be scrapped and replaced by new equipment conforming to the recommendations set forth herein.

Discussion.—The clause in the report—"All wheels must be numbered in accordance with instructions from the railroad company purchasing them, and must have the initials of such railroad company"—received considerable discussion. The idea of the committee was that a check would thus be placed on rejected wheels. Others thought that unless the initials were removed from rejected wheels complications might arise if they were purchased and placed in service by another company.

Action.—The report was referred to letter ballot for recommended practice.

COUPLER AND DRAFT EQUIPMENT.

Committee—R. N. Durborow, Chairman; F. W. Brazier, T. H. Curtis, T. Roope, G. W. Smith, F. H. Stark, G. W. Wildin.

FACE TESTS.

In the coupler reports for 1907 and 1908, figures were given showing the result of extensive investigations of coupler breakages, which demonstrated conclusively that a large percentage of all coupler failures are due to breakage through the face or front wall. The tests embodied in the present specifications do not cover this weak point in couplers, therefore, your committee made some preliminary experiments last year with a view of devising some test which would break the couplers through the face similar to the manner in which they are broken in service. The results of these preliminary trials were given in last year's report. The investigation has now been completed and the results from sixty-nine couplers tested to destruction, with drawings of apparatus for testing, are shown herewith.

These couplers, furnished both by different railroad companies and by manufacturers, were tested with the apparatus shown in Fig. 1. Fifty-seven of the couplers tested represented the standard types on the market at the time of testing; nine were special couplers manufactured for the face test and were tested by request of the manufacturers; the remaining three were malleable iron couplers. The following conclusions, from which the details of the new test are recommended, are based on the fifty-seven regular couplers. The nine special couplers gave slightly better results, showing the feasibility of procuring additional strength.

The coupler shank is wedged and bolted in the base-block casting with the striking horn and butt resting on the block and anvil, respectively. The wedging block, slightly modified from the one shown in the report of last year, to give more wedging action, is placed in the coupler head bearing on the lugs and

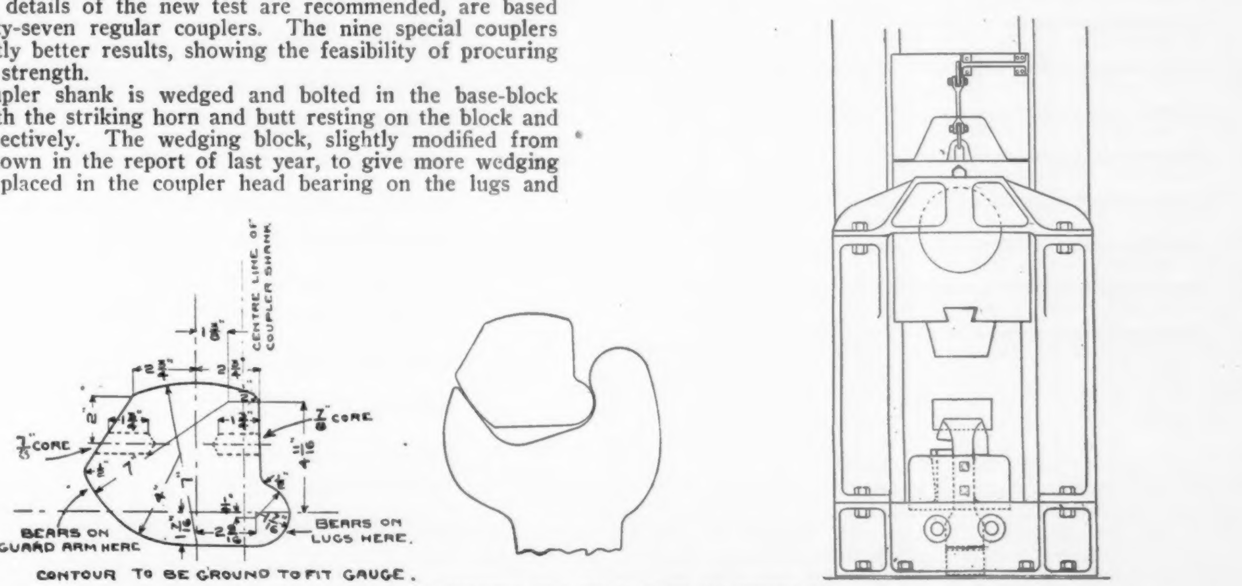
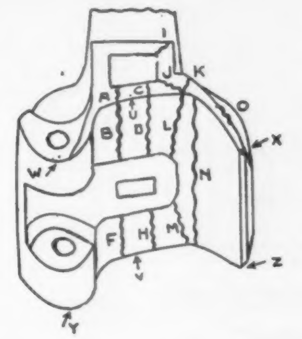


FIG. 1.—APPARATUS FOR FACE TESTS OF COUPLERS.

guard arm of the coupler. Blows imparted by the drop on the wedging block produce a spreading action on the coupler head, forcing the lugs and guard arm apart, which almost invariably breaks the coupler through the front wall. Fig. 2 shows the location and percentage of breaks in each place, showing the similarity to the service failures.

The couplers were subjected to three blows of five feet, followed by blows of ten feet until failure occurred. A coupler was considered to have failed when it was broken or when any cracks appeared more than 1-16 inch wide or more than one inch long. The average number of blows sustained by the fifty-seven regular couplers was three at five feet and one and one-half at ten feet, but as there were four out of eleven types which averaged better than this, and four additional types which had one or more couplers do better, the committee believes it proper to recommend that the test embody three blows at five feet and two blows at ten feet, with provision for retests provided the coupler stands three blows at five feet.

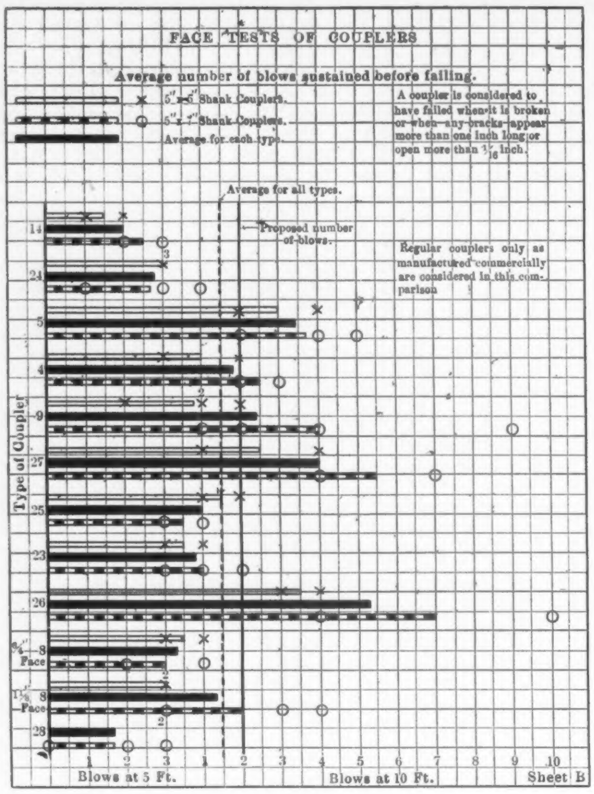


Location.	Number.	Per Cent.
B	20	29
L	20	29
A	18	26
M	17	25
K	15	22
C	8	12
D	6	9
I	5	7
J	5	7
F	4	6
H	3	4
N	1	1
O	1	1

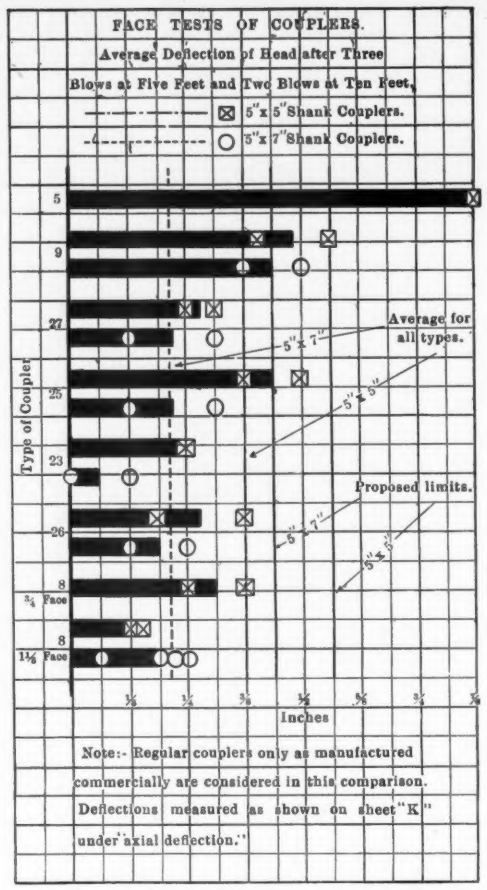
Couplers usually break in more than one place. Number of couplers tested, 69.

FIG. 2.

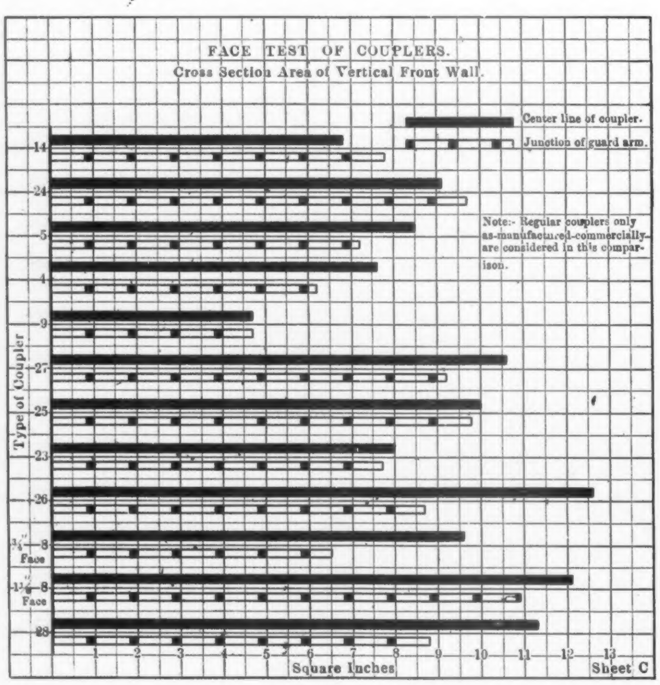
As explained above, the action of the wedging block when subjected to blows, spreads the lug and guard arm apart; it also bends the head on the shank just back of the striking horn. These deflections were carefully noted during each test and are shown on sheets "D" and "E," for all couplers on which these distortions could be measured after the second blow at ten feet. The deflections on the top of the coupler vary slightly from those on the bottom, but it does not seem necessary to specify limits for both top and bottom. The committee recommends that the limit for allowable deflection be ¾ inch for the guard arm for both 5 by 5 and 5 by 7 inch couplers; and 7-16 inch for 5 by 7 inch, and 9-16 inch for 5 by 5 inch shank couplers for the head and shank; both to be measured in the same manner as specified in the present guard-arm test. These limits are somewhat more liberal than might be considered advisable from the average of the recent experimental tests, which seems only fair, in that some of the couplers failed on account of the metal being too hard or brittle, which could possibly have been made



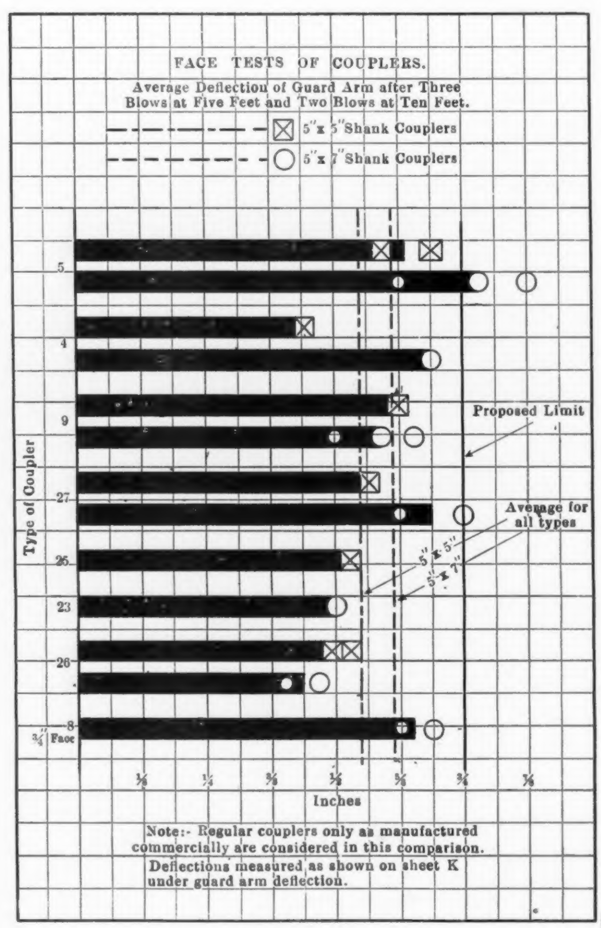
SHEET B.



SHEET D.



SHEET C.



SHEET E.

of softer material without injuring their fitness for service.

In the 1908 coupler report it was recommended and the recommendation subsequently passed the letter ballot, that all new types of couplers put on the market after January 1, 1909, have the dimension from the back of striking horn to inside face of knuckle increased one-half inch, and that the face or front wall must have a minimum thickness of 1¼ inches. The wisdom of this recommendation has been brought out by the experimental face tests, in which the couplers having the thickest front wall generally stood the largest number of blows. There were exceptions to this, but a careful study will show that these exceptions were due to one or the other of the following two reasons: First, some of the comparatively thick-faced couplers did not stand as many blows as some having thinner walls, due to kind of metal, improper annealing or defective castings. Second, some of the thin-faced couplers stood a comparatively large number of blows, due to soft metal allowing the guard arm to spread without breaking, but in most of these cases this guard arm deflection was excessive and indicated that the coupler would not be sufficiently rigid to properly withstand service shocks. The required number of blows and the allowable limits of guard arm and head deflections should prevent this.

The committee believes that physical tests will insure satis-

factory couplers, and that the chemical composition should be left to the judgment of the manufacturer. The manufacturers strongly object to the chemical specifications in addition to the physical tests, claiming that this restricts them to such an extent that they would have difficulty in meeting the physical tests.

It was found that the face test, in addition to the special vital features mentioned above, performs all the functions of the present guard-arm test, with the exception of the manner in which the shank is bent. The guard-arm test usually bends the shank throughout its entire length, while the face test only distorts it a few inches back of the striking horn, but as the shank-bending feature is also covered in the striking test, it is recommended that the guard-arm test be abolished and the face test substituted.

Recommended Changes in Coupler Specifications.

The present pulling test requires the use of two couplers. When a failure occurs, one coupler almost invariably gives out before the other and hence the one coupler only is being tested to destruction. This being the case the second coupler seems superfluous, and it is, therefore, recommended that one coupler be subjected to this test and that a dummy be used in place of the second coupler. This has been tried in several places for some time and found perfectly satisfactory. Previous to 1904 the jerk test embodied the use of two couplers, but has been found just as effective with one.

An outline of the proposed tests to be embodied in the specifications compared with the present is as follows:

PRESENT TESTS.		PROPOSED TESTS.	
Striking test	10 couplers.	Striking test	10 couplers.
Guard-arm test	1 coupler.	Face test	2 couplers.
Jerk test	1 coupler.	Jerk test	1 coupler.
Pulling test	2 couplers.	Pulling test	1 coupler.
Total	14 couplers.	Total	14 couplers.

Knuckle Pins.

A large number of bent and badly worn knuckle pivot pins are still found in service, necessitating very frequent renewals. Thorough examinations of pins removed from service have clearly demonstrated that the types which meet the specifications give comparatively very little trouble, and with the following exception these specifications have been found satisfactory: The specifications for knuckle pivot pins require that the pins must enter the plus end and must not enter the minus end of the recommended M. C. B. limit gauge for 1⅝ inch round iron. This allows a total variation of .022 inch, or only .011 inch above or below 1⅝ inch. As it has been found extremely difficult to procure steel within these limits, and as the committee believes them unnecessarily severe, it is recommended that a variation of 1-64 inch above or below 1⅝ inch diameter be allowed.

Tests have been made of nine different types of pins. The average angular distortion of only three types and all the pins of only one type meet the specifications. From this it is quite evident that many railroads are not buying knuckle pivot pins in accordance with the specifications. The committee, therefore, strongly urges the members to insist upon the observance of these requirements, and recommends that the specifications for knuckle pivot pins, which have been Recommended Practice for two years, be advanced to a standard of the Association with the changes herein recommended.

It has been found that the regular jerk, striking and pulling tests embodied in the specifications for automatic couplers are not severe enough on the knuckle pins. The committee, therefore, recommends that when couplers are inspected that a certain number of knuckle pivot pins be tested in accordance with the pivot-pin specifications.

The present coupler specifications and the separate knuckle specifications require that the holes for knuckle pins must not be more than 1-16 inch larger than the pin. Inasmuch as the specification for knuckle pivot pins allow a variation of only 0.011 inch each way, or 1-64 inch if the recommended change is adopted, 1-32 inch variation in the hole will insure the entrance of the pin without difficulty. Larger holes mean loose pins, with consequent wear and decrease in the life of the couplers. This change is therefore recommended.

A slight modification has been made in the apparatus for testing knuckle pins. The guide of the striking block was found to be of insufficient depth; 2¼ inches have, therefore, been added to the guide and to the block.

Some types of couplers are equipped with a device for preventing the lower portion of a broken knuckle pin from falling out. This tends to protect the upper lug from breaking when it receives the increased strain occasioned by a portion of the pin dropping out of the lower lug, but an arrangement of this kind makes it difficult for inspectors and others to detect broken pins. If a coupler is properly designed and fitted, the knuckle tail hook should prevent excessive strain to the upper lug. Under these circumstances the committee does not consider it wise at the present time to recommend a device for supporting broken knuckle pins.

Knuckles.

The coupler specifications require that the name of the coupler appear on each knuckle, but this requirement does not appear in the specifications for separate knuckles. The similarity of some knuckles of different makes as well as the large number of different types in service make it extremely desirable to have the name of the coupler shown on each knuckle. This is a great help to repairmen and often is the means of avoiding rather serious mistakes.

Proposed Inspector's Gauges, Attachment of Yoke to Butt and Changes in Drawings.

Inasmuch as it is not practicable to work to absolutely square corners in foundry and blacksmithing practice, the committee recommends that all drawings show ⅛-inch radius on the inside of yoke lip and 3-16-inch radius on corner of coupler butt.

In the 1907 report your committee made reference to the method of attaching yokes to butts. To insure proper fitting, gauges for both couplers and yokes have been designed and tried out, and it has been found that where couplers and yokes have been fitted to these gauges very little trouble is experienced. The gauges are shown on sheet "N." No. 1 is used on 6½-inch butt couplers to gauge rivet holes and lug for yoke fitting, length of butt and height of butt. No. 2 is the same for 9⅛-inch butt couplers. The tubes on gauges Nos. 1 and 2 are of sufficient length to pass completely through the coupler butt, therefore, if they are applied from both the top and bottom of the coupler, they will insure the top and bottom of the butt being in line as well as the proper spacing of the rivet holes. No. 3 gauges the width and height of shank and width of butt on both 5 by 5 and 5 by 7 inch shank couplers. No. 4 gauges the length of shank from back of striking horn to back of butt on both 5 by 5 and 5 by 7 inch shank couplers. No. 5 gauges the rivet holes and the lips on all yokes. As commented upon in the 1908 report, the trouble developed with the present method of attaching yokes to butts is due to improper fitting, such that the yoke lips stand away from the coupler butt and place all the strain on the rivets, which causes the latter to shear. If the use of the above gauges is rigidly observed the fitting will be such as to place nearly all the pull on the yoke lips and relieve the rivets from practically all shearing strain.

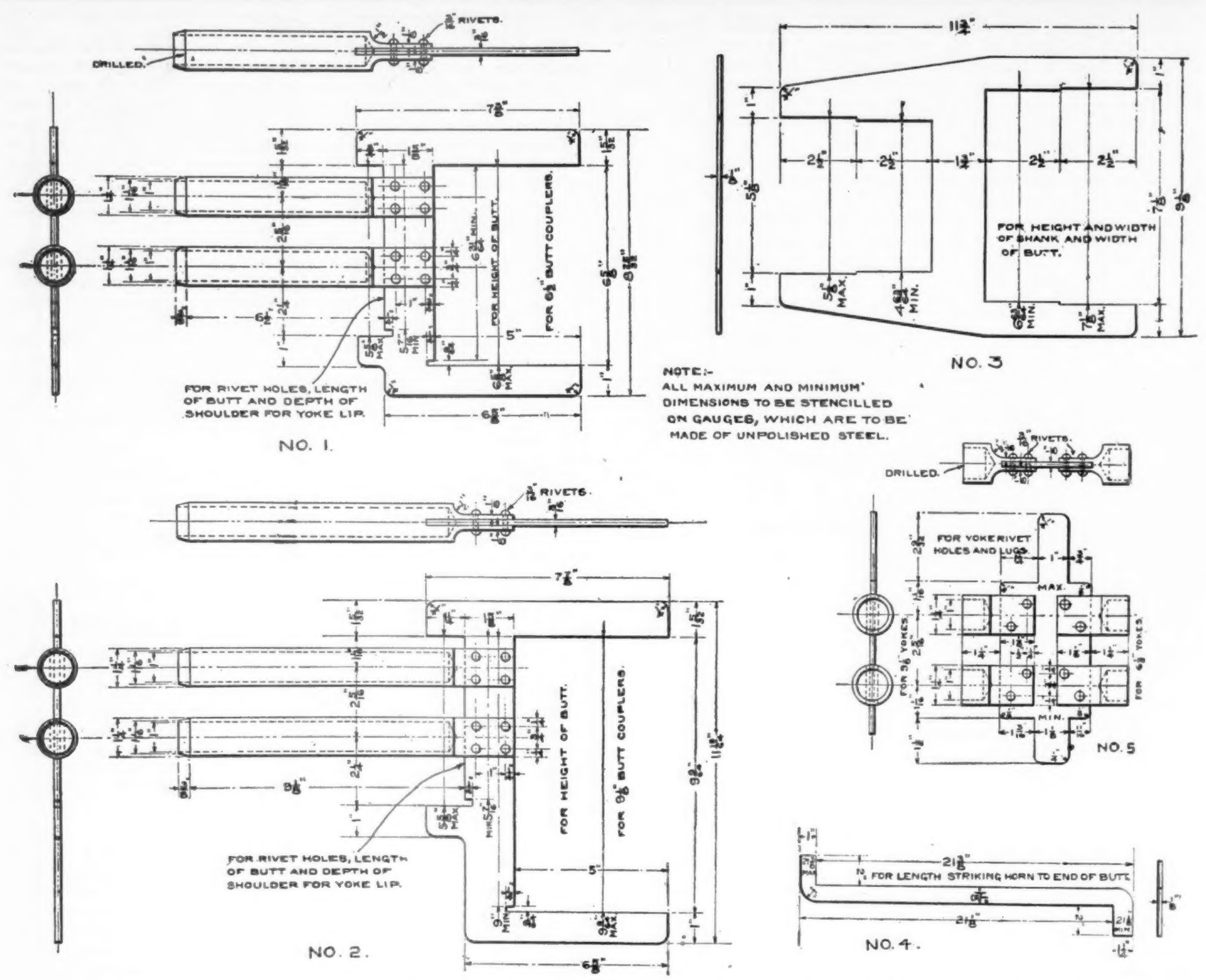
Mating of Couplers.

As mentioned in the report of last year, the contour of the knuckle tail on many couplers does not coincide with the contour of the coupler head; this leaves an opening between the knuckle lines and the lines of the coupler head when the knuckle tail is closed and often prevents easy couplings, as the point of the mating knuckle can not engage the knuckle tail continuously until the lock drops. If both knuckles of two engaging couplers are of the correct contour, the couplers will mate readily at very slow speed, but if the knuckles have the above-mentioned incorrect lines, they are only closed by coming sharply in contact with the front wall of the coupler heads. In other words, the knuckles should close each other and should not be pushed shut by the face of the opposing coupler. A note has been incorporated in the recommended revision of sheet M. C. B.-11, requiring the knuckle contour to coincide with the contour of the coupler head to the point where the lines of the knuckle tail diverge from the lines of the coupler face when the knuckle is closed, insuring the knuckle lines coinciding with the coupler contour lines as far as practicable.

Many couplers do not provide for a full knuckle opening; this lessens the available space into which the opposing coupler knuckle must enter and often prevents couplers from mating. The position and shape of the lugs on some couplers cause the same trouble by not providing sufficient opening across the coupler head from lugs to guard arm. To avoid the above, your committee recommends that the line tangent to the inside of the lugs must not be less than one inch from the longitudinal center line of coupler and that the knuckle must open sufficiently to clear this line.

Friction Draft Gear.

The committee regrets that it is unable at this convention to report on any definite investigation of the subject of draft gear performance. Broadly, the information desired is the proper resistance during the various stages of compression and the most desirable maximum capacity. A tentative discussion was given on this phase of the subject in the report of last year, as well as the results of a number of static tests, from which some useful information of a preliminary nature was derived. In order to procure definite information on the performance of existing gears, as well as information from which to base future designs, it is believed that the following policy should be followed: First, the carrying out of a comprehensive series of service tests with accurate recording devices; and, second, the design of a laboratory testing arrangement which will subject the gears to approximately the same pressures and shocks received in service. With the above in view, a study of previous tests has been made, but although data of exceeding interest has been placed at the disposal of your committee, by both railroad com-



INSPECTORS' GAUGES FOR COUPLER SHANK AND YOKE. (SHEET N.)

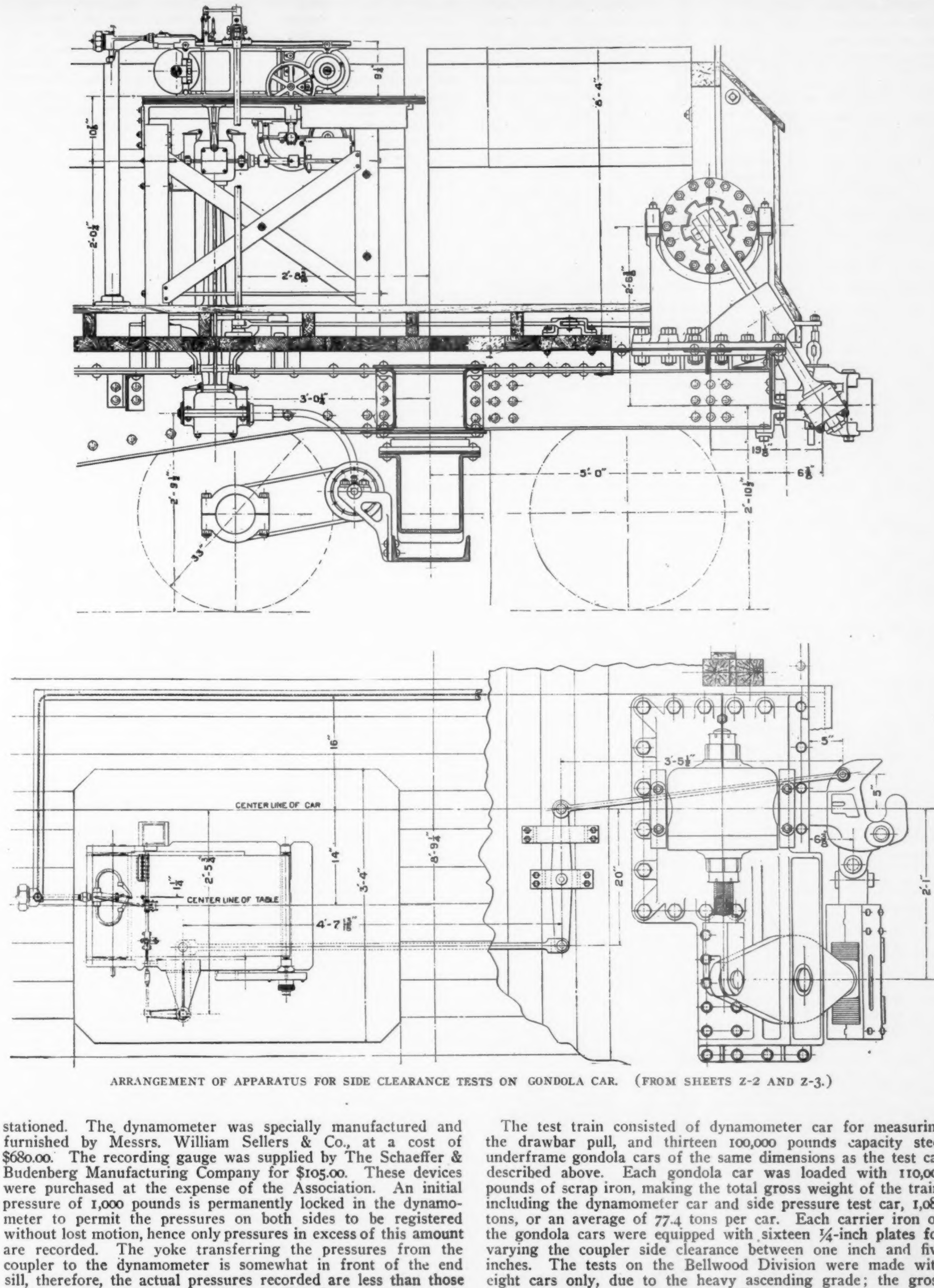
panies and manufacturing concerns, there is really little definite knowledge available.

An arrangement (shown on sheets "Z-2" and "Z-3") attached to a car coupler which recorded the position of the coupler, and hence the compression of the draft gear at any instant, was used in conjunction with the coupler side clearance tests referred to elsewhere in this report. Three types of gears were tested, two friction and one tandem spring. The average compression of those gears, and the drawbar pull is shown on sheets "R-1," "R-2," "R-3," "S" and "T" (not reproduced), giving the results of the coupler side clearance tests, but the compression at any instant, resulting from changes in pressure could not be determined, as the dynamometer measuring the drawbar pull is not designed to instantaneously record sudden changes or shocks. It was obvious, however, that one of the friction gears, called type "B" in this and last year's report, was not sufficiently sensitive, after the capacity of the preliminary spring, 19,000 pounds, had been reached. This was apparently due to sticking of the wedges. The amount of compression did not change until the drawbar pull had varied considerably and when the wedges did finally slip there was a noticeable shock, which must, in the long run, be injurious to couplers and their attachments and possibly to the car framing. The tandem spring gear responded readily to changes in drawbar pull, but in these tests no shocks, such as are encountered in making up trains and in shifting operations, exceeding the capacity of the gear, were experienced. As mentioned in the report of last year, the good friction gears are undoubtedly an improvement in protecting equipment from constant severe shocks due to their greater capacity and to their ability to absorb the force of the blows instead of returning it to the cars in the form of recoil as is done by the spring gears.

Coupler Side Clearance Tests.

The committee during the past year has conducted some very extensive coupler side clearance tests. The object of these tests was to determine the proper amount of lateral play for the coupler shank at the end sill on freight cars. It has been quite generally thought that couplers when curving exerted a very considerable side pressure on the end sill, and that this pressure was eventually transferred through the car framing and trucks to the wheel flanges. Some considered that this materially increased train resistance, while others thought that the pressure on the end sill was directed toward the inside rail and would, therefore, tend to pull the flanges away from the outer rail, thereby reducing flange wear and train resistance on curves.

A 100,000 pound capacity steel underframe gondola car, of forty-four feet eleven inches coupled length, thirty-three feet between truck centers, was equipped with a diaphragm dynamometer for measuring the coupler side pressure at clearances ranging from ½ inch to 5 inches in one-half inch stages. The clearances referred to in this report are total clearances, *i. e.*, by five-inch clearance is meant two and one-half inches on each side. A drawing of the dynamometer is shown on sheet "Z-1," and the general arrangement of the auxiliary testing apparatus is shown on sheets "Z-2" and "Z-3." A description of the dynamometer, which has been but slightly modified, was given in the report of last year. The side pressures are transferred through a yoke, having plates to vary the amount of clearance, and a lever to the dynamometer. A very slight movement of the dynamometer diaphragm, which has an area of forty-two square inches, displaces the liquid which, by means of a small copper pipe, spreads the arms of a recording gauge, of the Bourdon tube type. The capacity of the dynamometer is 50,000 pounds, and the recording gauge pen has a movement of two and one-half inches corresponding to this pressure. The gauge pen marks on paper driven by the wheels of the car, and the pressure at any instant is obtained by measuring the distance between the line made by the gauge-pen and the datum line made by a stationary pen. To facilitate working up the data the following information was also recorded on the traveling paper. Distance marks for each thousand feet, time every five minutes, locations such as mile posts, stations, point of curves, point of tangents, and marks showing whether or not the coupler clearance was taken up. The pens giving the above information are actuated by electro-magnets operated by observers conveniently



ARRANGEMENT OF APPARATUS FOR SIDE CLEARANCE TESTS ON GONDOLA CAR. (FROM SHEETS Z-2 AND Z-3.)

stationed. The dynamometer was specially manufactured and furnished by Messrs. William Sellers & Co., at a cost of $680.00. The recording gauge was supplied by The Schaeffer & Budenberg Manufacturing Company for $105.00. These devices were purchased at the expense of the Association. An initial pressure of 1,000 pounds is permanently locked in the dynamometer to permit the pressures on both sides to be registered without lost motion, hence only pressures in excess of this amount are recorded. The yoke transferring the pressures from the coupler to the dynamometer is somewhat in front of the end sill, therefore, the actual pressures recorded are less than those to which the end sills are subjected. The figures given in this report represent the correct end-sill pressures and are computed by adding twenty per cent to each recorded pressure. The dynamometer was calibrated previous to the tests on a static testing machine and it was retested after the tests, and the readings were found to correspond with the original calibrations.

The test train consisted of dynamometer car for measuring the drawbar pull, and thirteen 100,000 pounds capacity steel underframe gondola cars of the same dimensions as the test car described above. Each gondola car was loaded with 110,000 pounds of scrap iron, making the total gross weight of the train, including the dynamometer car and side pressure test car, 1,084 tons, or an average of 77.4 tons per car. Each carrier iron on the gondola cars were equipped with sixteen ¼-inch plates for varying the coupler side clearance between one inch and five inches. The tests on the Bellwood Division were made with eight cars only, due to the heavy ascending grade; the gross tonnage in this test was 612 tons. The dynamometer car measuring the drawbar pull was placed at the head of the train on the pulling tests and at the rear of the train on the pushing tests. The side clearance test car was placed third in the train with the test coupler forward on most of the tests, but other positions were tried.

The tests were conducted on portions of three different branch-line divisions of the Pennsylvania Railroad, and the length of the test runs, exclusive of the distance required to start and stop, was as follows: Cresson Division 5.87 miles, Bellwood Division three miles and Monongahela Division nine miles. In addition to the road tests, trials with the test car and one other, were conducted through a No. 8 switch and a No. 6 slip switch with only sixteen feet of tangent track intervening, and also on an industrial curve having a minimum radius of sixty-eight feet.

From the results of twenty-three tests on the Cresson Division it was found that the drawbar pull, or train resistance, varies very slightly, 28.22 pounds per ton being the maximum, and 25.86 pounds per ton, the minimum, and from the following averages of all the tests on the division, it is seen that the train resistance is not affected by the coupler side clearance.

Comparison of average train resistance and coupler side clearance, Cresson Division:

Side Clearance.	Average train resistance—pounds.
1 inch	28,685
2 inches	28,992
4 inches	28,525
5 inches	29,303

It would be difficult to find a better location for tests of this character, as the curves are sharp and close together and are not compensated. There are only four places on the stretch of 5.87 miles where the entire train is on a tangent, and in these cases it is only a few feet before the next curve is entered. The train resistance due to a thirteen-degree curve in addition to level tangent and grade resistance is about thirteen pounds per ton, therefore, if it were affected by variations in couplei side clearance, it would readily be detected on a division of this character. In order to eliminate any variations in train resistance, which might be attributed to changes in temperature between the different tests, the car journals were warmed by running the train nine miles at a speed of about fifteen miles an hour immediately before each test. The tests on the other two divisions, while not so numerous, checked the results obtained on the Cresson Division, showing no variation in train resistance due to lateral coupler play.

A summary of the maximum coupler side pressures with the corresponding amount of side clearance and the degree of curve on which they were obtained, is given below. The

COUPLER SIDE CLEARANCE TESTS.

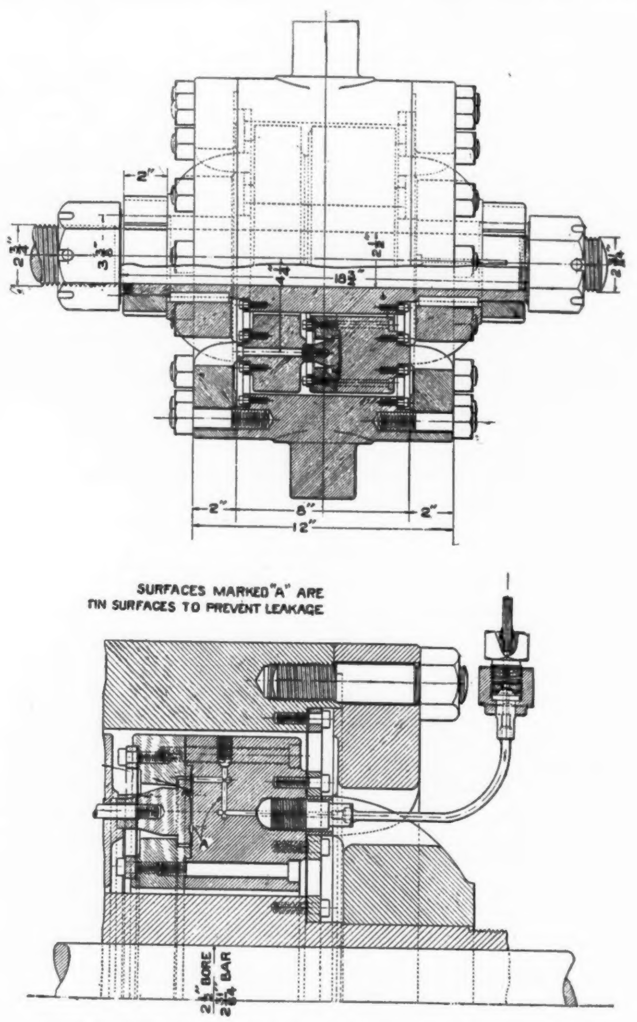
SUMMARY OF MAXIMUM SIDE PRESSURES AT END SILL. LBS.

Total Side Clearance	Cresson Division. Sharpest Curve 13°00′ Average Draw Bar Pull at Test Coupler 25033 Pounds.	Bellwood Division. Sharpest Curve 22°30′ Average Draw Bar Pull at Test Coupler 32306 Pounds.	Monongagela Div'n. Sharpest Curve 16°00′ Average Draw Bar Pull at Test Coupler 15286 Pounds.
One Inch	4800	7100	5200
Two Inches	2400	3000	2600
Three Inches	....	1600	....
Four Inches	0	....	....
Five Inches	0	....	.. .

..... Indicates no tests made.
° Indicates no pressures.

maximum pressure iecorded on the unusual curve of 20° 30′ was, with one-inch clearance 7,100 pounds, two-inch clearance 3,000 pounds and three-inch clearance, which is standard to the car, 1,600 pounds. None of these could be considered injurious to the equipment, when the vast number of shocks and strains to which cars are almost continually subjected are considered. The recorded pressures on all the pulling tests were exerted toward the inner rail of the curve, but in so far as the observers could ascertain they did not have any effect tending to pull the wheel flanges away from the outside rail. The side pressures are, roughly, the resultant force formed by the drawbar pull and the angularity between the coupled cars on a curve. With the class of cars used in these tests, this angle is about seven degrees on a thirteen-degree curve, which gives a theoretical side pressure of about 3,000 pounds with a drawbar pull of 25,000 pounds. The actual side pressure is sometimes in excess of and often less than this amount, due to numerous variables, such as swinging of the cars and binding of the coupler knuckles. There are portions on sharp curves where a clearance as small as one inch is not taken up, due to the above-mentioned variables. The plots on sheet "Y" gives approximately the relation between this phase of coupler clearance and the degree of the curves and also the relation between side pressure and degree of curve. The pressures obtained in the pushing tests were not as large as on the pulling tests, and apparently bore no fixed relation to the degree of the curves; in fact, slight pressures were recorded on tangent tracks due to the coupler contour lines allowing the heads to be pushed out of the direct alignment. Similar conditions were obtained on the drifting tests; in the latter, however, the slight pressures seemed mainly to be due to the swerving of the cars. It was thought that the length of the coupler yoke might affect the side pressures, therefore, one test, No. 42, was made with a long tandem spring yoke attached to the test coupler, but no difference in the lateral pressure was obtained. With this exception all of the cars were equipped with friction draft gears and their corresponding yokes. It must be kept in mind that all the results given in this report are based on one class of car, the side pressures on shorter cars would doubtless be somewhat less, varying with the overhang and distance between truck centers.

The yard tests with two loaded cars on a curve with a minimum radius of sixty-eight feet developed very excessive side pressure even with five-inch side clearance; in fact, it was not practicable to push the cars all the way around the curve, as the pressures were in excess of the dynamometer capacity. These same tests with empty cars gave practically the same results, except that the wheels at the test-coupler end of car were lifted about one inch off the outer rail during the trial with one-inch clearance. The side pressure on these tests is principally due to severe cornering of the end sills. Service of this kind, however, may be considered abnormal and would



COUPLER SIDE CLEARANCE DYNAMOMETER. (SHEET Z-1.)

require a total lateral coupler play on reverse curves of thirty-eight or forty inches, which would make necessary excessive and expensive changes in car construction, and more or less elaborate centering devices. The committee does not consider that curves of this character are encountered often enough to make these changes advisable, and can only suggest that auxiliary couplers, or some other method of handling the cars, be adopted under these conditions. A side pressure of 12,000 pounds was obtained with one-inch clearance in pushing the test train through a No. 6 slip switch followed by a No. 8 switch with sixteen feet of tangent track intervening. The following results were obtained by running two loaded cars through these same switches: one-inch clearance, 4,800 pounds; two-inch clearance, 2,200 pounds; three-inch clearance, 1,400 pounds.

Conclusions.—In concluding the portion of the report relative to coupler side clearance, the committee would like to make special mention of the following deductions, drawn from the results of the tests: First, train resistance and, therefore, the

amount of tonnage hauled under general road conditions is not influenced by coupler side clearance; second, the side pressures exerted on the end sills of cars by the couplers are not excessive with two and one-half-inch clearance on any road or on any normal yard curves, and third, it is recommended that the present standard side clearance of "Not less than 2½ inches," be changed to read simply "2½ inches," as this is ample and there is a liability of couplers not mating if more clearance is allowed without centering devices.

SUMMARY.

A summary of the recommendations which the committee offers to be submitted to letter ballot to be adopted either as standard or recommended practice is as follows:

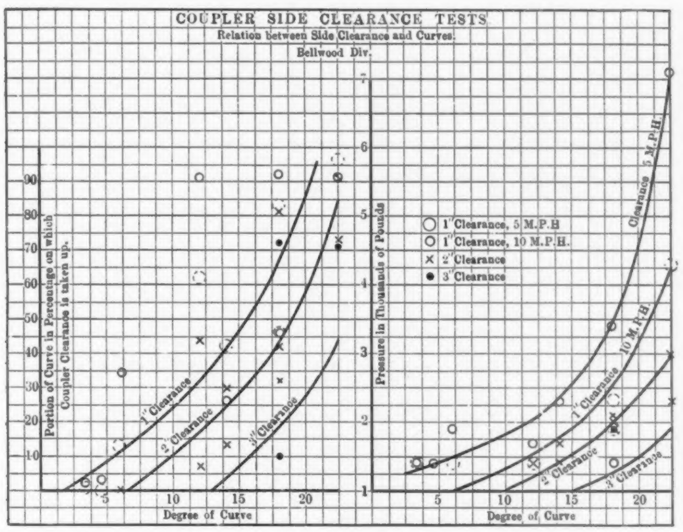
STANDARDS.

Specifications for M. C. B. automatic couplers:

1. That the guard-arm test be abolished and the face test substituted in its place, two couplers to be so tested.
2. That one coupler instead of two be submitted to the pulling test.
3. That the holes for knuckle-pivot pins must not be more than 1-32, instead of 1-16 inch, larger than 1⅝-inch diameter pivot pin.
4. That six knuckle pivot pins be tested in accordance with the specifications for knuckle pivot pins for every one thousand couplers purchased.
5. That the gauges shown on sheet "N" be adopted as Standard of the Association and that Section 6 and Section 1 under "Inspection," be modified to require their use.

SPECIFICATIONS FOR SEPARATE KNUCKLES.

6. That the holes for knuckle pivot pins must not be more than 1-32 instead of 1-16 inch, larger than 1⅝-inch diameter pivot pin.
7. That each knuckle must bear the name of the coupler



SHEET Y.

legibly stamped or cast at some point where it will not be subject to wear.

SPECIFICATIONS FOR KNUCKLE PIVOT PINS.

8. That these specifications be adopted as a Standard of the Association.
9. That all pins must not be more than 1 41-64 inch or less than 1 39-64 inch in diameter, determined by a suitable gauge.
10. That word "weight" be replaced by words "standard weight of 1,640 pounds," in first sentence under "Physical Test."

Drawings:

11. That sheet M. C. B.-11 be changed to conform to sheet "O" accompanying the report.
12. That the present standard coupler side clearance of "Not less than 2½ inches" be changed to "2½ inches."

RECOMMENDED PRACTICE.

1. That sheet M. C. B. "B" be changed to conform to sheet "P" accompanying the report.

Discussion.—Mr. Sanderson suggested increasing the limit of 150,000 lbs. for the pulling test. He also directed attention to the fact that the cars in the trains on which the side clearance tests were made were all of the same length, but that in actual service a 40 ft. and a 60 ft. car might be coupled together resulting in a greater stress on the coupler shanks than indicated by the tests. In replying to him Mr. Kleine called attention to the fact that the limit of the pulling test had been increased only last year and while there were couplers which had been tested to over 300,000 lbs., it would hardly be wise to make another change at this time. He also stated that the different lengths of overhang would not make much difference on regular road curves, but would on sharp curves often found on industrial sidings or even on cross-overs.

Mr. Brazier emphasized the importance of adopting a standard coupler and presented data as to the large amount of money tied up by the necessity of carrying the different types in stock. He also emphasized the doing away with of the top uncoupling arrangement in favor of a side or bottom arrangement. Mr. Gaines suggested that while the proper fitting of the yoke to the coupler was satisfactory still it is difficult to get it properly done by the average workman and that it might be well to provide a wall about the rivet through the butt.

Mr. Fowler (Can. Pac.) stated that a yoke properly fitted to the coupler butt would give satisfaction and that during the past five years 60 per cent. of yoke failures had been eliminated on the Canadian Pacific by careful attention to this matter.

Mr. Onderdonk (B. & O.) suggested that a flexible connection between the coupler and the yoke would probably give better service than the present arrangement.

Action.—The report was accepted and ordered referred to letter ballot.

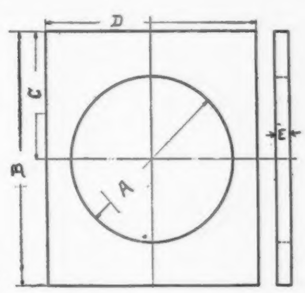
FREIGHT CAR TRUCKS.

Committee: A. Stewart, Chairman; J. J. Tatum, A. S. Vogt, J. F. DeVoy, G. A. Hancock.

(A) To submit standard dimensions for dust guards for the four standard journal boxes.

The dimensions for the four dust guards recommended are shown on Sheet No. 1. There is no recommendation for material from which standard dust guards should be made, it being the opinion of the committee that there are a great many different materials proper for this purpose.

(B) To add to Sheet M. C. B. 22 journal-box bolt and dimensions



JOURNAL	A	B	C	D	E
3¾"×7"	4 13/16"	7½"	3¾"	6"	⅝"
4¼"×8"	5 5/16"	8¾"	4⅜"	7¼"	⅝"
5"×9"	6 3/16"	9¾"	4⅞"	8"	⅝"
5½"×10"	6 11/16"	10¼"	5⅛"	8¾"	⅝"

FIG. 1.—STANDARD DIMENSIONS FOR DUST GUARDS.

The above instructions are followed by submitting Sheet No. 2, which is recommended to be substituted for the similar parts shown on Sheet M. C. B. 22, with the addition of the journal-box bolt.

(C) To specify single nut with nut lock under head and nut of bolt.

We submit Sheet No. 2, which it is suggested be used in place of similar parts shown on Sheet M. C. B. 22, and to which has been added the journal-box bolt with nut lock under head and nut of bolt, and a revised column bolt with one nut in place of two, and a nut lock under the nut and head of the bolt; with a notation that where a cast washer is used under the head of the bolt in place of a nut lock, it shall be constructed to prevent the head from turning.

(D) To specify a nut lock under head of column bolt on which single nut with nut lock is used, where washer is used under head in place of nut lock, the same to be constructed to prevent head from turning.

We submit, in answer to this, the same Sheet No. 2 which is recommended to be added to Sheet M. C. B. 22, in place of similar parts as now shown. This sheet and the notations take care of the references under heading (d).

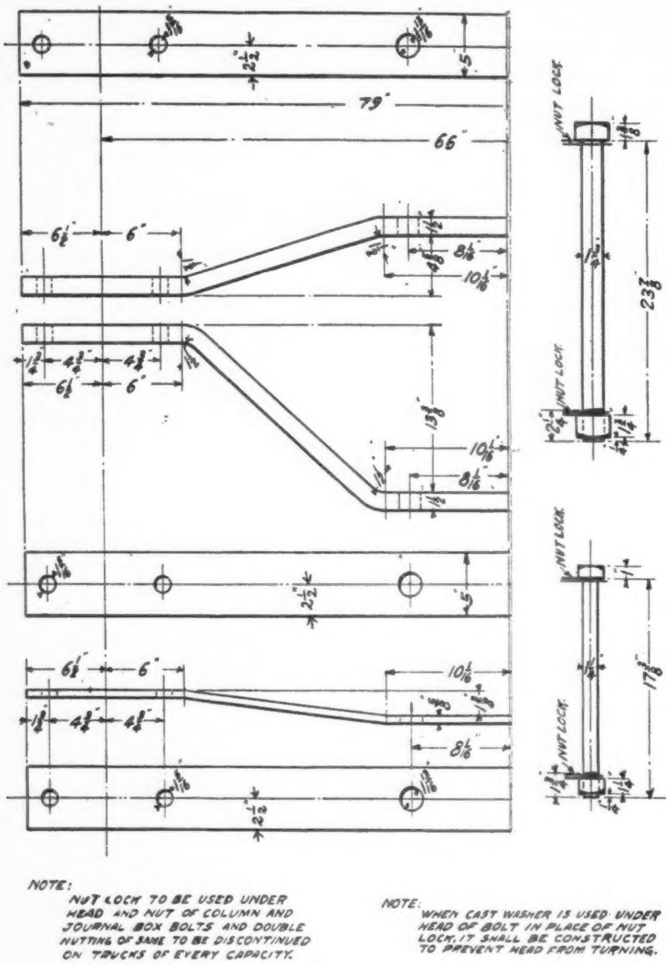
(E) To specify the use of nut locks at top and bottom of all column and journal-box bolts, and discontinue the

double nutting of such bolts.

We submit Sheets Nos. 2 and 3, on which are shown the column and journal-box bolts for both 80,000 and 100,000 lb. trucks, with specifications to cover a suitable nut lock at the top and bottom of these column and journal-box bolts, and a further notation which is to be used in connection with this report in recommending that the practice be discontinued of double nutting column and journal-box bolts on trucks of every capacity.

(F) To submit standard designs for arch bars and column and journal-box bolts for 100,000 lb. capacity trucks.

To cover this, we submit Sheet No. 3, showing proposed design for arch bars, column and journal-box bolts. In suggesting this design of arch bar, it has been largely based on the reports of satisfactory performance of cars now in service, of 100,000 lb. capacity. The average area of the top and bottom arch bars of all the 100,000-lb. capacity trucks we could get a record of is 7½ in., and the majority have both the top and bottom arch bars of the same dimension, or 5 by 1½ in., with a cross-section area of 7½ in.



PROPOSED STANDARD ARCH BARS FOR 50-TON CARS.

(G) To ascertain whether there is any necessity for higher spring capacity for 100,000-lb. capacity trucks.

All of the replies received, except one, indicate that 10 per cent. overload is the universal practice. The average 100,000-lb. capacity car will weigh 40,000 lb., and the standard Class D spring is designed to carry 38,000 lb. at a height of 7¼ in. and 64,000 lb. when solid, making the normal working capacity 152,000 lb., which is also the capacity of the 100,000 lb. or D axle, having journals 5½ by 10 in.

It is the suggestion of a number of roads to increase the spring capacity, but the committee was divided on this, two members advocating an increase in the spring capacity to allow for an overload of 25 per cent., the other three members taking the view that, as the present spring has a capacity equal to the designed capacity of the truck and axle, a greater capacity should not be recommended unless taken up in connection with a larger axle and increased capacity of truck.

The following subjects were referred to this committee by the Committee on Standards and Recommended Practice:

The vertical clearance between the side lugs on the journal bearing and the journal wedges is ⅛ in. for 3¾ x 7 in. and 5½ x 10 in. journals, and 1/16 in. for 4¼ x 8 in. and 5 x 9 in. journals.

In the opinion of the committee, 1/16 in. is too small a clearance, taking into consideration that the parts are rough castings; it is recommended that the clearance be increased to ⅛ in. for the four standard sizes of bearings and 1/16 in. reduction be made in the brass for the 4¼ x 8 in. and 5 x 9 in. boxes, as shown on Sheets M. C. B. 6 and 15.

There is no dimension given for a standard depth of hood of M. C. B. standard journal-box lid. The committee feel that, provided the lug on the journal box is maintained standard, it will be better not to limit the manufacturers in the design of their box lids, provided they properly fit the standard lug.

Attention is called to the opening in the back of the box for 5 x 9 in. and 5½ x 10 in. journals. It is recommended to change M. C. B. Sheet 14, showing 5 x 9 in. journal box, and this recommendation is concurred in by the committee, which suggests that the dust-guard opening and back of the 5 x 9 in. box for freight cars be made similar to the 5 x 9 in. box for passenger cars, as shown on M. C. B. Sheet C. Consideration has also been given the 5½ x 10 in. box, as shown on M. C. B. Sheet 17, but the committee has no changes to recommend.

Action.—There was no discussion of the report and the recommendations of the committee were ordered referred to letter ballot as recommended practice.

TANK CARS.

The committee recommended a change in the rules of interchange to provide for the stenciling of limit weights on tank cars. It also presented designs and recommendations for vents for cars carrying non-inflammable or non-volatile material. Recommendations were also made as to the center sill construction and as to longitudinal anchorage of the tank. The preferable method of securing the tank against end shifting is by anchoring it to the underframe at or between the bolster, rather than by means of head blocks, inasmuch as the latter method results in damage to the underframe forward of body bolster.

The report of the committee was ordered submitted to letter ballot and the committee was continued.

TOPICAL DISCUSSIONS.

Thos. Paxton presented some facts concerning the need of suitable lugs on steel and steel underframe cars for the jacking up of car bodies; also the application of suitable push-pole pockets to avoid damage to cars.

A rather warm discussion was precipitated by H. D. Taylor, who spoke on—Is a brake burn on wheel due to prolonged brake application properly an owner's defect? How is it to be distinguished from the defect known as shelled out? The matter was finally referred to the arbitration committee.

The abuse of the M. C. B. repair card was considered by W. H. Lewis. The facts which he presented and the remarks made by other members indicated a rather deplorable state of affairs in some instances. The following resolution, presented by Mr. Parish, was adopted:

That all of the members of the association who have any evidence of dishonesty in the use of the repair card submit such evidence to the executive committee, who will undertake to investigate the whole matter thoroughly and handle it in such a manner as seems best to the interests of this organization. It must be distinctly understood that no case should be presented to this committee until it has been sent to the head of the department that is questioned.

W. T. Gorrell presented some data concerning wheel mounting pressures for various sizes of cast iron and steel wheels. The question will probably be referred to a special committee to report at the next convention.

T. L. Burton read a comprehensive paper on the cleaning of triple valves and brake cylinders. J. R. Alexander, chief air brake inspector of the Pennsylvania Railroad, told of some investigations in the matter of lubricating triples which indicate that the proper operation of the valve does not depend on lubrication; in fact, valves have given no trouble when run without a lubricant during the cold weather season.

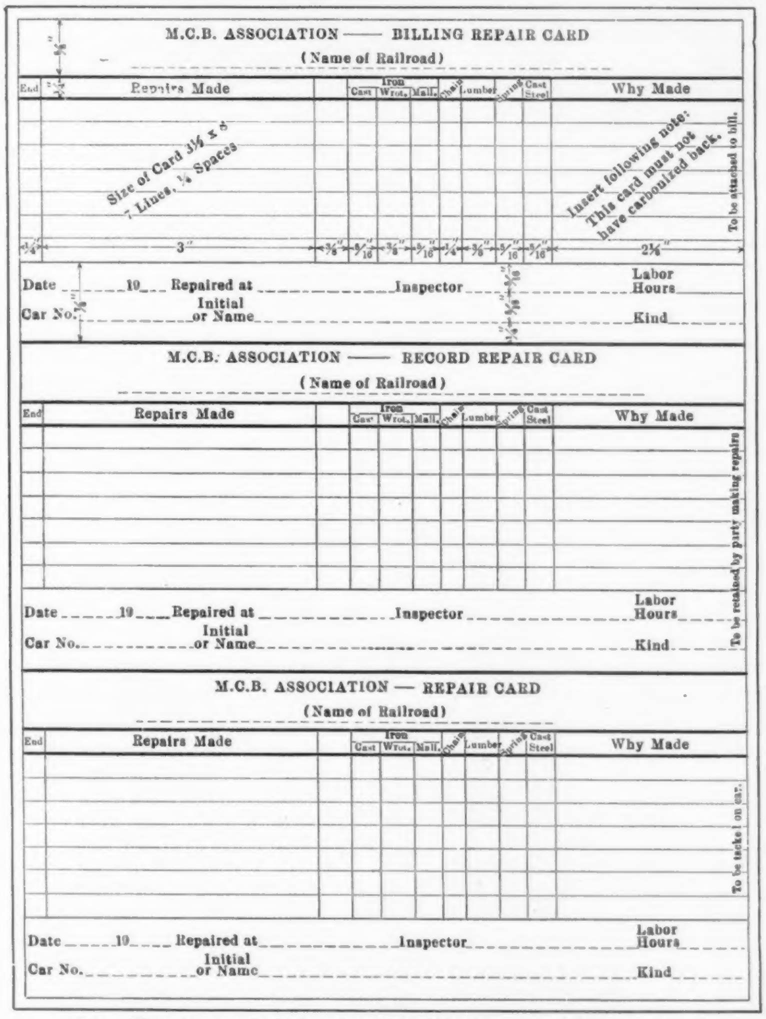
REVISION OF THE M. C. B. REPAIR CARD AND QUESTION OF SETTLING CAR REPAIR BILLS ON A MILEAGE BASIS.

Committee: J. F. Deems, Chairman; D. F. Crawford, F. H. Clark and J. G. Neuffer.

The committee submits the following recommendations:

Because of a desire to have a card that can be made in triplicate and that will contain additional information to facilitate the making of bills, a great many roads have gotten away from the standard form of M. C. B. repair card. After considering the various cards in use, it is believed the form provided below will answer the requirements and should be used by all railroads.

The principal changes in the repair card are in providing a form that can be made out in triplicate, in one writing if desired, by using carbon sheets instead of having to fill out two stubs and repair card separately; also providing columns to show weights and miscellaneous charges for different items of material to facilitate the making and checking of bills. The proposed repair card consists of a billing repair card to be attached to the bill, a record repair card to be retained by party making repairs, and a repair card to be tacked on car.



Note.—The printing on back of repair card should be the reverse of that shown here. The billing repair card must not have carbonized back.

M. C. B. REPAIR CARD.

The repair card to be tacked on car shall be printed on cardboard, on both sides, with black ink, and shall be filled in on both sides, one side to be filled in with ink or indelible pencil. The billing repair card shall show the same information as on the repair card and be attached to the bill as authority for charge, and must not have carbonized back. The record repair card shall be retained by the party making repairs.

The use of above cards will be effective June 1, 1910.

The committee recommends the following addition to Rule 88, providing a special repair card, if desired, for changes in wheels and axles: "In exchanging wheels and axles under foreign cars, reports on repair card of M. C. B. standard size, embodying all information required by the following statement, will be acceptable."

It is further recommended that the reporting of shop marks be discontinued, as this information does not appear to be necessary for the proper record of wheels and axles.

Concerning the suggestion of making repair bills on a mileage basis, the committee does not consider such a plan feasible. Any such arrangement would have to be based on average conditions, and the committee does not feel that the cost of maintaining cars in the various sections of the country is sufficiently alike at the present time to warrant it in assuming that such a basis would be an equitable one. While the operation of the present rules calls for a large expense from a clerical standpoint, the making of bills on M. C. B. defect cards, destroyed cars and charges for owners' defects, would still have to be carried on if the proposed plan was adopted, and the possible saving would be offset by the additional cost of inspection, loss to car owners' account of deterioration of their equipment on foreign lines and additional clerical help that would be necessary to adjust discrepancies, which would, no doubt, develop under the proposed system.

Action.—The recommendations of this committee were included in the report of the arbitration committee and adopted so that no action was necessary other than that of receiving the report.

SIDE BEARINGS AND CENTER PLATES FOR FREIGHT AND PASSENGER CARS.

Committee—R. D. Smith, chairman; R. P. C. Sanderson, J. H. Manning, J. F. Walsh, G. C. Bishop, F. F. Gaines, C. A. Schroyer.

The committee found that it would cost at least $4,000 to make the necessary laboratory tests and therefore asked the superintendents of motive power of five roads owning dynamometer cars if they could arrange to make certain practical tests to determine:

1. The resistance to turning of different types of center plates.
2. The effect of lubricating center plates.
3. The resistance to turning of different types of side bearings.
4. The effect of varying the clearance of side bearings with a view to determining the best clearance.
5. The effect of varying the spread of side bearings with a view to determining the best spread.

These tests were to be made on stretches of level track about three miles long, consisting of two tangents with a curve of from 8 deg. to 12 deg., 500 ft. to 600 ft. long between them. By means of a dynamometer car the pull of a train of five or six 80,000 or 100,000 lbs. capacity cars was to be measured under various conditions, the cars being loaded with material of such nature as car wheels which would allow of varying the distribution of the load.

All of the roads replied that owing to the depression in business and the fact that forces had been greatly reduced, they did not care to undertake the tests at this time.

The committee again recommended that an appropriation sufficient to have tests made at some engineering university be considered at some future time when business conditions warrant.

Discussion.—A lengthy discussion took place, following the presentation of this report, as to the value and accuracy of results which could be gained from dynamometer car tests. It was finally decided to refer the matter to the executive committee.

Non-Magnetic Yacht.—The non-magnetic yacht *Carnegie,* in the construction of which practically no iron or steel was used, was launched at Brooklyn, N. Y., June 12. The only metal in the entire ship that is not non-magnetic is that of the pistons, the gas producer and the range grates. It will be used for obtaining correct records of magnetic variations and will be manned by a picked crew selected by the Carnegie Institution, Washington, D. C., for which the vessel was built.

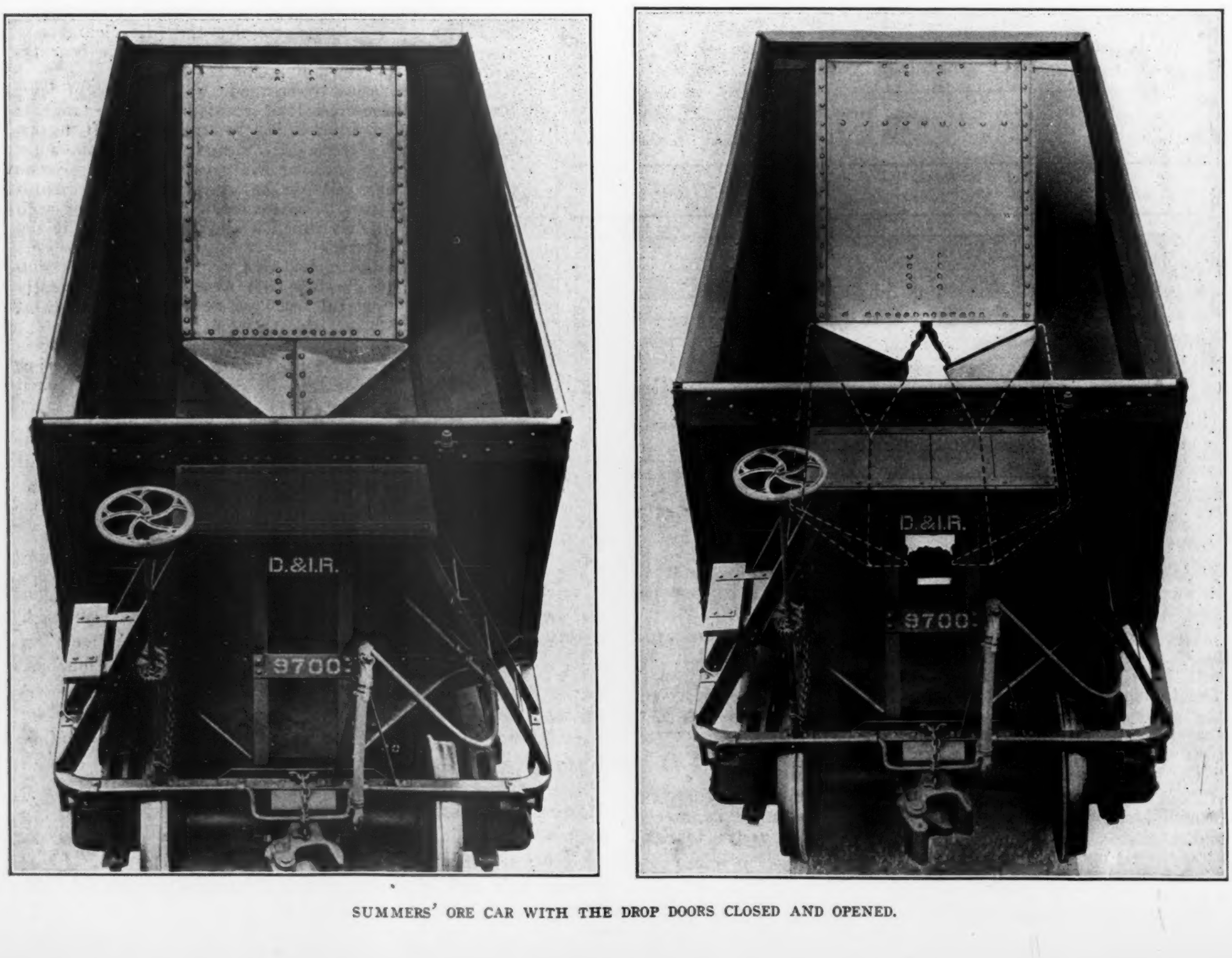
The Pennsylvania Railroad Company has 6,292,156 shares outstanding. This is divided among 57,540 shareholders. 47.96 per cent. of the shareholders are women; 17,332 are located in Pennsylvania and 18.79 per cent. of the capital stock is held abroad.

FIFTY-TON STEEL ORE CAR—DULUTH & IRON RANGE RAILROAD.

SUMMERS' STEEL ORE CAR.

The Duluth & Iron Range Railroad has eight hundred Summers' ore cars that have been in service for some time and are making enviable records as compared with other types of cars in the same service. These cars were illustrated and described in our February issue, page 49. It has been found that the workmen, when working at their usual rate of speed, will unload from 40 to 50 of the Summers cars in the same time required for unloading one of the ordinary steel hopper cars.

As an example, the following data was taken while the men were working at their usual rate, not realizing that they were being watched closely or that the time of the various operations was being observed:



SUMMERS' ORE CAR WITH THE DROP DOORS CLOSED AND OPENED.

MAKE	NO. CARS	NO. MEN	COMMENCE TO OPEN DOORS	ALL ORE OUT AT	DOORS CLOSED AT	TIME CONSUMED Min. Sec.	AVER. PER MAN PER CAR Min. Sec.
Summers	10	6	3·35:15 P.M.	3:38·38 P.M.	....	3 : 18	2 : 0
"	10	6	3:29 P.M.	3:32:20 P.M.	....	3 : 20	2 : 0
Old Type	10	42	3:54 P.M.	4:19 P.M.	....	25 : 00	105 : 0
Summers	8	3	4:47 P.M.	....	4:54 P.M.	7 : 00	2 : 37½
"	16	6	5:07 P.M.	....	5.13 P.M.	6 : 00	2 : 15

The first three items of ten cars each all contained the same kind of ore and the time did not include closing the doors after the loads were out. The time for the last two items of 8 and 16 Summers cars included closing the doors ready to load again.

A number of the cars have recently been equipped with an air operating mechanism for opening and closing the doors. The total time required to open the doors, drop the load and close them, ready for reloading, is from 10 to 15 seconds per car. A 50-ton load has been unloaded and the door closed in as low as 8 seconds. The air equipment is used only to open and close the doors, they being held mechanically in the closed position with a positive lock. As iron ore is a very sticky material to handle, it is preferred to give each car individual attention. It is possible though in this way for one man to unload a thousand cars in a ten-hour working day. For years it has been the practice to have from six to ten men per car, punching the ore out through the trap bottom. The new type of car makes it possible to dispense with hundreds of men at each dock.

The Summers' cars are unloaded immediately on being spotted over the pockets in the dock and are pulled off at once, the engine and crew making but the one trip to and from the dock with each lot of cars, while with the older cars two trips were necessary and they were delayed in movement, it being impractical, after the engine has once left them, to go back after them as soon as they were unloaded.

Following are some of the more important advantages of the Summers' car:

First.—Cost of unloading is only about 1 per cent. of that for the old cars.

Second.—Cars are kept on the move and a less number are required to handle a given tonnage.

Third.—The tonnage capacity of the dock is increased almost directly with the increased number of cars that may be unloaded over a given pocket.

Fourth.—The number of men required will very much reduce the possibility of a labor tie-up when the movement of a great tonnage is necessary.

Fifth.—The lake vessels can be loaded with greater dispatch. Ships and cars earn money only when moving under load.

BELTING.

The following plan has been suggested by the New York Leather Belting Company for endorsement by belt users whereby the user may be assured of securing a good grade of belting.

Demoralizing Practices in Belting.—The average buyer of belting is not a leather expert. It is difficult to distinguish a good quality leather belt from a glossed-over imitation of quality. The buyer at present must depend on "claims of value" made by the seller. His lack of ability to test belting on delivery makes it impossible for him to tell whether he is having delivered best-quality goods or slick and shiny third-grade belly stock. Knowing this condition to be so prevalent, unscrupulous belting manufacturers have practiced flagrant fraud on the consuming public, making "claims of highest value" to get an audience, and prices low enough to get the business, and then delivering any sort of belting they saw fit.

Plan to Protect Users of Belting.—1. Have all belting manufacturers who have facilities for building best quality belting adopt a standard specification for first grade belting, viz.:—

(a) Belting made from oak-bark tanned butts.

(b) Only center portions of hide used.

(c) Strips put into belts not to exceed 4 feet 6 inches in length.

(d) Weight about 16 ounces to the square foot.

(e) Every strip for each width of belt taken from a definite fixed location in the hide.

2. As physical proof to the user that these claims are fulfilled in the belting delivered, we offer this absolute test, easy to apply and sure in its proof. Each manufacturer shall furnish to every dealer who represents him, a belting butt, having sides and centers attached, with strips to illustrate the exact nature of material which enters into every width into which the belting will be manufactured. By comparing the roll of belting with strips in the sample butt, and by comparing the pit of the leather in the roll with that in the corresponding strip in the belt, a novice in belting may prove to himself just what he is getting. Every large user of belting should have a sample butt of this sort at his plant.

3. A stamp shall be adopted which will be recognized as a national quality stamp for first grade belting. All manufacturers who can prove they are capable of building belting according to standard specifications, shall be allowed to place this stamp as a guarantee on their first-grade goods.

4. This stamp shall be the property of a national committee representing the supply dealers of the country, since they supply 50 per cent. of the belting used by consumers. This committee shall withdraw the use of this stamp from any manufacturer who uses it on goods which do not meet standard specifications.

5. The verified complaints of any belting users that goods bearing this stamp which do not fulfil the specifications, have been delivered, shall be sufficient to have the stamp withdrawn from that manufacturer. This would hold an axe over the head of every manufacturer and insure absolute fulfilment of specifications.

The Protection This Plan Gives.—The adoption of this plan will eliminate the possibility of fraud in the delivery of belting, since it gives the user a double check: (1) Physical proof that he can apply for himself. (2) A guarantee in the shape of a national quality trade-mark.

SUPERHEATED STEAM.

The following data and corrections will make more clear certain parts of Mr. Cole's article on "Low, Moderately and Highly Superheated Steam," which appeared in the June issue.

The values of specific heat of superheated steam used in computing the table near the top of the left hand column of page 223 are those appearing in the table in the opposite column. The total heat for 160 lbs. pressure and 40 degs. of superheat should be 1,220 in place of 1,222, as shown.

The fourth word in the first line at the top of the right hand column on page 223 should read "pressure" instead of "volume," thus making the complete sentence read: "The average specific heat of superheated steam of different pressures at various temperatures, but of constant pressure for the different curves, is given in Fig. 2."

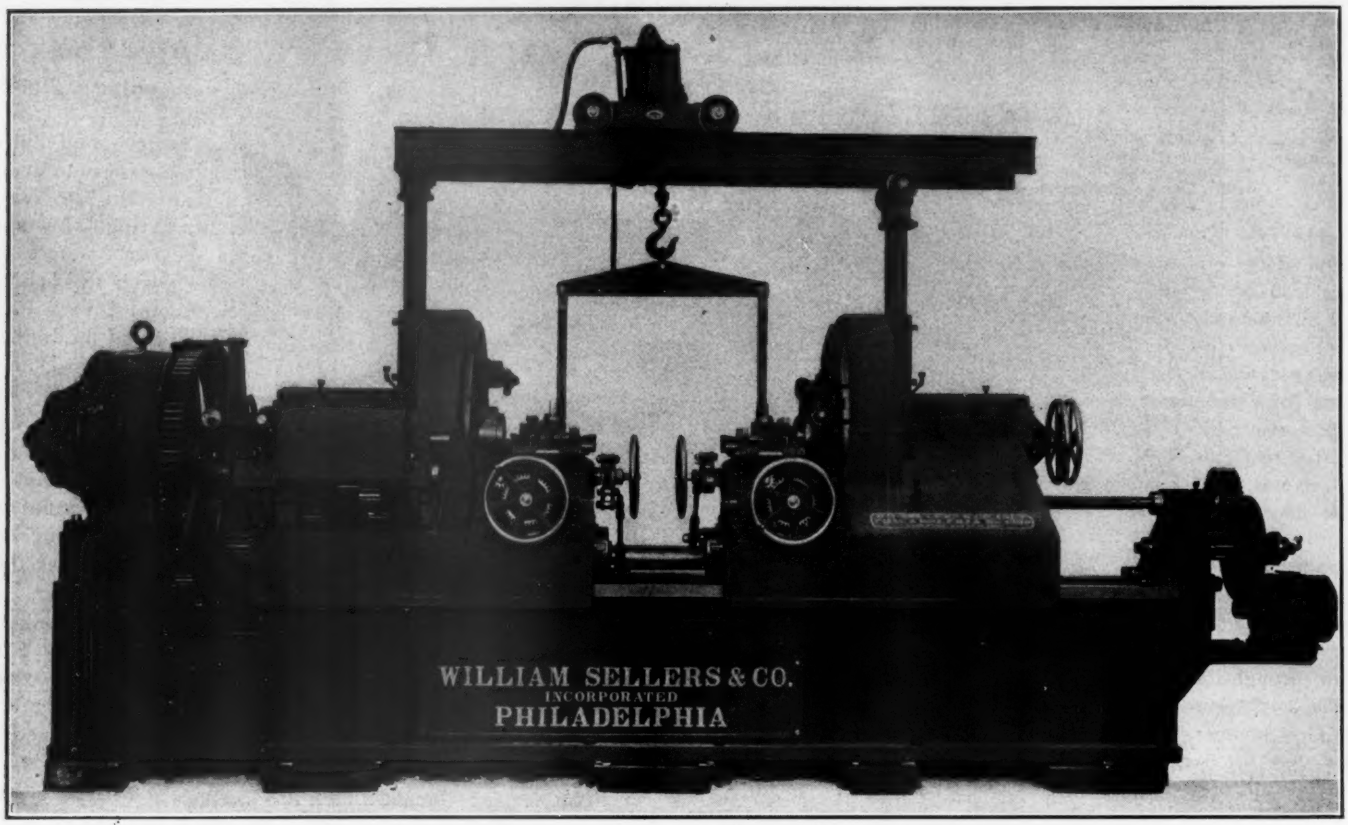
At the top of Fig. 3 on page 223 a reference is made to a formula which appears on page 661 of Kent. The formula is not, however, in quite this form, but is derived from the one shown in the following manner:

$$PV = 93.5\ T - 971\ p^{1/4}$$

$$\text{From which } V = \frac{93.5\ T - 971\ p^{1/4}}{P}$$

$$\text{and since } W_t = \frac{1}{V}$$

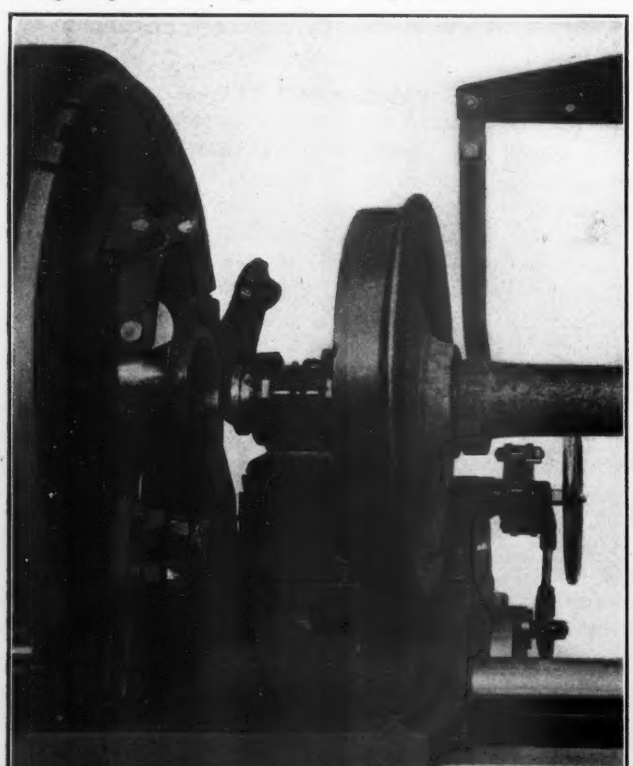
$$\text{then } W_t = \frac{P}{93.5\ T - 971\ p^{1/4}}$$



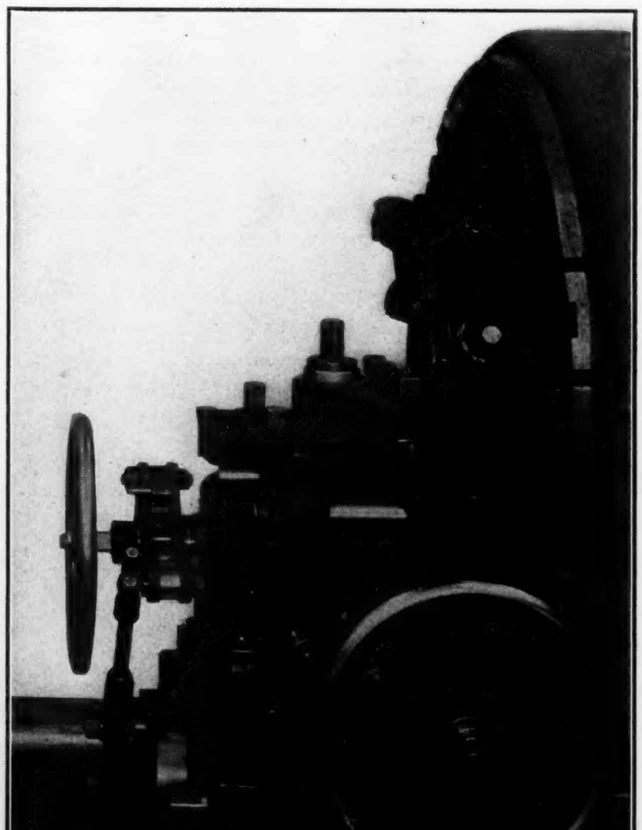
SELLERS' MOTOR DRIVEN CAR WHEEL LATHE.

CAR WHEEL LATHE.

A test was recently made at the works of William Sellers & Company, Philadelphia, of a car wheel lathe, lately designed by them. William Anthony, an operator from the Philadelphia & Reading shops at Reading, was in charge of the machine. Four pairs of steel-tired wheels (three 36 in. with outside journals and one 33 in. with inside journals) were turned in 72 min. 28 sec. This includes the time required to place them in the lathe,



SHOWING FACE PLATE DRIVERS, BUSHING ON JOURNAL AND TRACK CAST ON EXTENSION OF HEADSTOCK.



TURRET TOOL HEAD, CARRIAGE, AND FACE PLATE DRIVERS.

turn them and replace them on the floor. It does not include 6 min. for changing the lathe for the pair of wheels with inside journals and 27 sec. for replacing a burned tool.

The lathe is designed to turn car wheels of any type, with either inside or outside journals, and from 28 to 42 in. in diameter. The bed, of massive construction, carries one fixed and one movable head, the latter being traversed by an electric motor driving a screw through a slip clutch, which is adjusted to slip if the head should come in contact with a solid obstruction. The two face plates are driven in unison by a large driving shaft.

For centering wheels with outside journals three-part taper bushings, held assembled by a couple of turns of coiled spring, are slipped over the journals. These bushings enter taper-mouthed spindles in the headstocks, thus centering the wheels. These spindles are provided with springs to maintain a uniform pressure on the taper bushings. For engine truck wheels, having inside journals, pointed centers and bushings are provided to fit the taper holes in the spindles.

Each face plate carries three positive toggle grip drivers for holding the wheels. The toothed cam at the end of the lever is brought into contact with the wheel by a slight turn of a small wrench, forcing the serrated block at the other end of the lever to engage the tire. Any tendency to slide when the tool starts to cut causes the cam to revolve and increases the pressure of the serrated block against the tire, preventing further slipping.

The main casting of each head is extended forward along the bed forming a support for the slide rest and the stresses due to the cut are therefore self-contained in the head and there is no tendency to lift the head off the bed. The four tools required for turning the tire are held in a turret head. A partial turn of the wrench is sufficient to tighten or release the turret which may be readily turned when free. It is locked in position by two cams which bear against one of its sides. These are operated by a crank and the turret is turned by a wrench which engages with the square head bolts near the corner. The roughing tool is placed in a slot through the turret and clamped by four screws. If the tool should become dull or broken it may be passed out backward and replaced without stopping the lathe or revolving the turret. The finishing tools are mounted on ledges cast on the sides of the turret.

As there is no part of the machine between the wheels it is possible to place a pair in the lathe having gears or even armatures on the axle. On the back of each saddle is cast a track to match tracks on the shop floor so that wheels may be rolled directly below the lathe centers. They may thus be handled to and from the lathe without a crane and, if desired, it will only be necessary to furnish a hoist as shown in one of the illustrations.

The lathe is driven by an adjustable speed motor controlled by an automatic solenoid switch panel. By the use of these switches the operator is able to start and stop the machine and reduce to an extremely low speed without stopping when passing hard spots. After the hard spots have been passed the lathe will resume the speed at which it was running by merely releasing the slow-down switch. The perfect control of the cutting speed thus obtained has a marked effect on the productive capacity. A brake stops the machine promptly when the current is shut off.

OIL FURNACES FOR RAILROAD SHOPS.

The advantages of oil for use in heating furnaces in railroad shops are being quite generally recognized. The labor of bringing coal to the furnace and hauling ashes away is done away with; no storage space for fuel is required in the shop; a uniform heat is obtained, and it is under perfect control; the fire is quickly started.

A Kirkwood heating furnace in the smith shop of the Jacksonville, Florida, shops of the Seaboard Air Line is shown in the illustration. A combination high and low pressure burner is used; the oil is fed to the burner at a pressure of from 15 to 25 pounds and is there atomized by a small quantity of compressed air at a slightly lower pressure, after which an air blast of from two to six ounces is used to supply the necessary amount of oxygen for complete combustion. The amount of compressed air required is very small. This type of burner is said to be responsible for a very considerable reduction in the oil consumption.

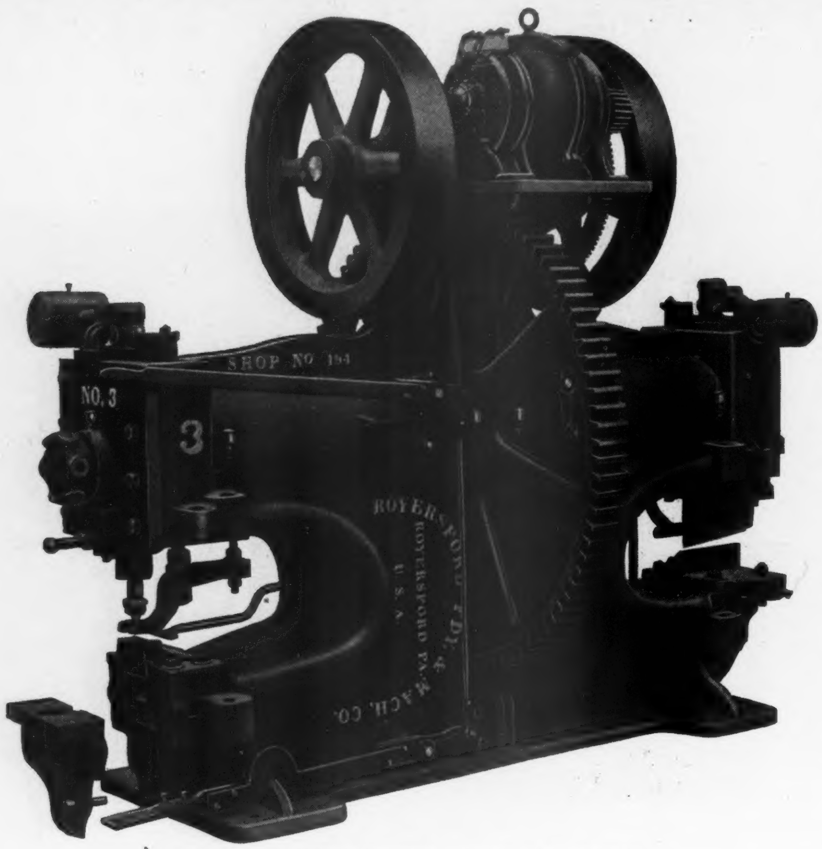
KIRKWOOD OIL FURNACE IN SEABOARD AIR LINE SHOPS AT JACKSONVILLE.

Another important feature is that the supply of oil and compressed air is controlled by one lever, thus keeping the ratio between these two constant. This ratio is carefully adjusted before the furnaces leave the factory, and is beyond the control of ignorant or careless workmen. The nature of the fire may be regulated by varying the amount of the air blast. These furnaces are made in a number of different types and sizes by Tate, Jones & Company, Inc., of Pittsburgh.

BARTLEY NUT AND BOLT FASTENER.

Following is a memorandum designating some of the bolts on cars on which Bartley nut and bolt fasteners are being used by different railroads: Air brake and pipe clamp, air brake cylinder, air brake reservoir, box car roof fascia, brake lever fulcrum, brake hanger, brake lever guide, carry iron, center plate, column and column guide, dead lever guide, draft rigging, draft timbers, end sill gusset and brake mast, grab iron, journal box, ladder rung, pedestal brace, queen post, safety chain, safety hanger, side step and pocket, spring plank, tie bar, truss rod; also on all bolts and nuts on both wood and steel cars that are liable to work loose from vibration or other causes.

It may readily be seen that the above bolts will require fasteners of different types. Among these are the arch bar style, used on the heads of bolts and the nuts on journal boxes and columns and any other place on iron or steel surfaces where the center of the bolt hole is within about three inches or less of a square edge over which the flange of the fastener will lap. For channels or similar places the fasteners of the above type are furnished with inverted flanges. The slotted arch bar style is used under the column bolts on old cars; the bolt is driven up about an inch and the fastener is pushed under the head until its flange slips into position over the arch bar—this saves time and possible injury to the bolt in driving it



ROYERSFORD MOTOR DRIVEN PUNCH AND SHEAR.

clear out. A multiple style is used where bolts are uniform distances apart, or where they do not come near enough to the square edge to permit the use of the arch bar style. They are desirable for air brake cylinders, draft rigging and such places and may be furnished in one strip for from two to six or more bolts.

A diamond tang style is used on wood, dispensing with the use of a separate washer and combining the washer and nut lock in one. The rail type is without flanges and is applicable to cars or locomotives where a projecting bearing for the lower edge of the fastener comes within moderate distance of the bolt. The lower edge of the fastener can be shaped to fit bearing surfaces of irregular shape. Special shapes and styles may be furnished to suit almost any conditions. The fasteners are manufactured from a uniform grade of mild steel. The locking arm is bent into locking position at a long radius, and will not, therefore, break or crack when necessary to release the nut. The same fastener may be used quite a number of times without breaking.

These fasteners are made by The American Nut and Bolt Fastener Company, of Pittsburgh, represented in the east by Robert Spencer & Co., 20 Vesey street, New York, and in the west by Christopher Murphy & Co., 164 Dearborn street, Chicago. The plant at Pittsburgh has a capacity of sixty million fasteners a year.

MOTOR DRIVEN PUNCH AND SHEAR.

The punch and shear, illustrated herewith, has a shearing capacity of 8 by 1 in. flat, or 2 in. round. It will shear 5 by 5 by ⅝ in. angles. Equipped with tie rods it will punch up to 1½ in. through 1 in. It may be furnished with either 26 or 32 in. throats and with a 4 in. extension on the punch side, which may be used for light punching up to 1 in. through ¾ in.

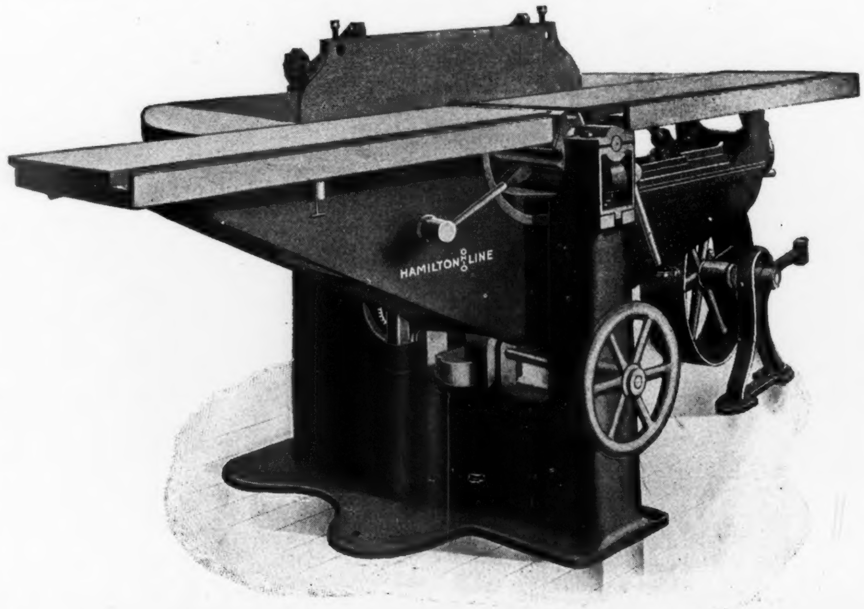
The main shaft, in two parts, is 5½ in. in diameter, and is eccentrically turned near the ends to provide a movement of 1¾ in. to the plungers, or moving heads. Each side is independent of the other, although both sides may be operated together if desired. The operation is controlled by the hand lever or foot treadle; forcing them down throws the clutches into contact with the large gear; when released the springs on the side of the machine throw the clutches out.

The machine is provided with a gag on the punch side for accurate punching; also with an architectural jaw for conveniently punching I-beams and channels. Angle and slitting shears may be attached if required. The machine may be furnished with a 12-in. instead of a 26-in. throat on the shear side. With 26-in. throats on both sides it weighs 18,300 pounds equipped with the motor. This is one of a line of punches and shears (single or double), made by the Royersford Foundry & Machine Company, Inc., Royersford, Pa.

UNIVERSAL OR VARIETY WOODWORKER.

The Hamilton universal woodworker is constructed in a most substantial manner for handling the large and heavy work required in railroad shops. It is carefully designed to withstand the strains to which it may be subjected in performing various operations, including jointing, smoothing, planing out of wind, squaring, beveling, tapering, rabbeting, gaining, plowing, cornering, beading, mitering, tenoning, panel raising, hand matching, moulding, rip and cross cut sawing, boring and routing.

It is made in four sizes, eight, nine, ten and twelve inch, and has three table tops, which are adjustable independently and collectively. The two front tables are carried on a heavy bracket that is adjustable up and down on the front face of the frame without disturbing the adjustment of the two tables relative to each other. The front or forward table has an independent adjustment up and down and to and from the cutter-head through four incline slides mounted on the bracket. The third table or back top is found on this make of machine only and is of great importance for handling large and heavy work; it has an independent adjustment up and down. For cross gaining or similar work the three tables may be brought to a uniform level, furnishing a table support of large dimensions. The front tables are provided with wide grooves for the reception of slide boards, gauges, and other accessories.

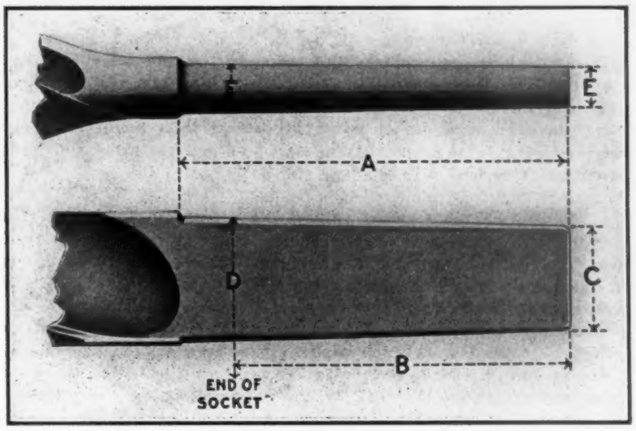


HAMILTON 10-INCH AND 12-INCH SOLID WOODWORKER.

If desired the machine may be provided with an additional cutter-head, mandrel and housing set vertically at right angles to, and in the rear of the horizontal cutter-head. This head is used when planing and squaring material on two sides at one time. When so arranged an additional fence is provided, which may be set for any amount of cut on the side head. The other fence, shown in the illustration, is used when the horizontal head only is in use. Either the single or the double machine may be equipped with a universal adjustable boring and routing table by the manufacturers of the machine, the Bentel & Margedant Co., Hamilton, O.

A NEW SHANK AND SOCKET FOR FLAT TWISTED DRILLS.

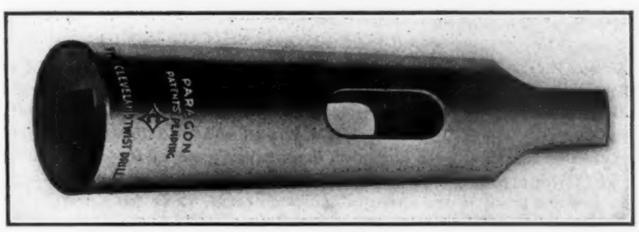
The Cleveland Twist Drill Company is about to place on the market a high speed twisted drill with a new type of flat taper shank, known as the "Paragon"; also "Paragon" sockets to fit



SHANK ON "PARAGON" FLAT TWISTED DRILLS.

these shanks. The drill itself is twisted from flat stock and the shank is forged and ground to size from the original bar without weld or joint. The shank has a uniform taper on the flat sides, as well as on the rounded edges.

A regular taper shank sleeve outside, with a flat tapered hole



"PARAGON" DRILL SOCKET.

inside to correspond to the shank, is all that is required to hold the drill. A good true fit is thus secured, resulting in a firm accurate drive, with the strain distributed over the entire length of the shank—leaving no weak point to break or twist off. The sockets are simple and inexpensive, and are furnished in either rough, fitted, or sleeve styles. The combination is thus simple and strong, and it would seem that it was the logical way in which to drive a drill of this type.

PERSONALS.

J. F. Casey has been appointed foreman of the car department of the Fort Worth & Rio Grande.

Oscar J. La Paugh has been appointed division storekeeper of the Delaware & Hudson at Green Island, N. Y.

C. B. Dobson, car foreman of the Chicago, Rock Island & Gulf at Dalhart, Tex., has been appointed district car inspector.

C. W. Van Buren has been appointed master car builder of the eastern lines of the Canadian Pacific with office at Montreal, Que.

C. Kyle has been appointed general master mechanic of the eastern lines of the Canadian Pacific, with office at Montreal, Que.

S. S. Shields has been appointed general air-brake inspector of the Atlantic Coast Line Railroad Company, with office at Wilmington, N. C.

A. M. McGill,, general inspector of motive power and rolling stock of the Lehigh Valley, has been appointed shop superintendent at Sayre, Pa.,

E. L. Sudheimer, master mechanic of the Chicago Great Western, has resigned to go with the Peteler Car Company of Minneapolis, Minn.

H. S. Wall, master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, has been appointed superintendent of shops at San Bernardino, Cal.

J. A. Conley has been appointed master mechanic of the New Mexico division of the Atchison, Topeka & Santa Fe, with office at Raton, N. Mex.

L. A. Mattimore has been appointed master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, with headquarters at Needles, Arizona.

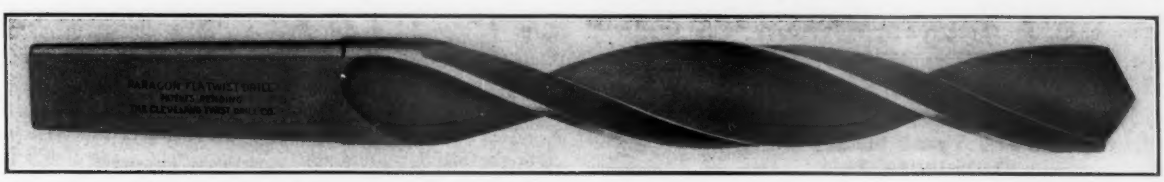
C. J. Morrison, standardizing engineer of the Atchison, Topeka & Sante Fe has resigned to engage in other business, and is at present located in New York City.

M. F. McCarra has been appointed general foreman of the Kingsville shops of the St. Louis, Brownsville & Mexico, to succeed A. J. Conrad who has resigned.

A. W. Whiteford, shop superintendent of the Lehigh Valley at Sayre, Pa., has been appointed assistant superintendent of motive power with office at South Bethlehem, Pa.

J. T. Connor has been appointed superintendent of motive power and machinery of the Houston, East & West Texas and the Houston & Shreveport at Houston, Texas.

C. H. Temple, formerly master mechanic of the Central division of the Canadian Pacific, has been appointed assistant superintendent of motive power, with headquarters at Winnipeg, Man.



"PARAGON" FLAT TWISTED DRILL.

C. F. Richardson has been appointed assistant to the superintendent of motive power of the Chicago, Rock Island & Pacific, in charge of fuel economy, with office at Chicago.

P. H. Cosgrave, formerly with The Colorado Midland Railway Company, has been appointed general car foreman of the Denver & Rio Grande, with office at Salt Lake City, Utah.

C. Setzkorn, district car inspector of the Chicago, Rock Island & Gulf at Dalhart, Texas, has been appointed a general car foreman of the Chicago, Rock Island & Pacific at Cedar Rapids, Iowa.

James Kiely, master mechanic of the New Mexico division of the Atchison, Topeka & Sante Fe, has been appointed master mechanic of the Rio Grande division, with office at Clovis, N. Mex.

A. V. Manchester, assistant district master mechanic of the Chicago, Milwaukee & St. Paul, at Minneapolis, Minn., has been appointed a master mechanic of the Chicago, Milwaukee & Puget Sound, with office at Miles City, Mont.

D. E. Fitzgerald, for the past five years chief clerk to the general superintendent of motive power, has been appointed assistant general superintendent of motive power of the St. Louis & San Francisco, with office at Springfield, Mo.

W. E. Ballantine, chief electrician of the Chicago, Rock Island & Pacific, will work in future under the jurisdiction of the mechanical department officials, and, subject to their approval, will have charge of car and engine electric lighting and will give such assistance with regard to electric appliances for shop use as may be required. The electric lighting at all points on this road where the current is supplied by mechanical department facilities will be under the direct supervision of the mechanical department. At other points the electric lighting will be under the supervision of the superintendent of telegraph.

BOOKS.

Poor's Manual for 1909. Published by Poor's Railroad Manual Co., 68 William street, New York. Price, $10.

This is the forty-second annual number and has 100 more pages than the 1908 edition and 400 more than the 1907 book. The statistics cover the 1908 fiscal and calendar years, and in some cases information is given which was received after June 1, 1909. In addition to the railroad data, there is a comprehensive industrial section.

The total mileage of the steam railroads in the United States, December 31, 1908, was 232,046 miles, an increase during the year of 3,918 miles. The surplus for 1908 was $49,444,376, or only 30 per cent. of that for 1907, which was $172,572,926. The surplus in 1906 was $151,474,773; in 1905, $121,876,014; in 1904, $92,620,020. The following items are of interest:

	1908.	1907.
Passengers carried	891,275,003	860,648,574
Passenger mileage	28,985,670,148	28,166,116,577
Revenue per passenger mile	1.950 cents.	2.040 cents.
Tons freight moved	1,521,065,494	1,722,210,281
Freight mileage	215,698,911,350	233,137,507,807
Revenue per ton mile	0.765 cent.	0.782 cent.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

ELECTRIC MOTORS FOR THE OFFICE, STORE AND SHOP.—The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has issued a handsomely printed booklet describing a few typical applications of its line of small motors for office, store and shop services. It includes illustrations and descriptions of a motor-driven adding machine, mailing machine, eraser, graphophone, envelope sealer, vacuum cleaner, buffing and polishing wheel, blower, air pump, sign-flasher, box-covering machine, hand drill. hack saw, coffee grinder, etc.

A REVOLUTION IN LIGHTING.—This is the title of a booklet, No. 3841, just issued by the General Electric Company. It tells in a simple way of the advantages of the tungsten lamp.

ELECTRIC POWER FOR DOMESTIC PURPOSES.—The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has prepared an attractive little folder, which offers many valuable suggestions for the use of small motors in the home. Among the labor-saving applications of electric power noted are the sewing machine, vacuum cleaner, washing machine, ice-cream freezer, coffee grinder, meat chopper, ironing machine, silver polisher, dish washer, and the motor-driven pump.

POWER PUNCHING AND SHEARING MACHINERY.—An attractive catalog of 208 pages has just been received from The Long & Allstatter Company, Hamilton, Ohio. It is known as catalog No. 21 and opens with an illustrated description of the various tools used in connection with punching and shearing machines. This is followed by diagrams of both a single and a double punch and shear showing the names of the different parts. The remaining 194 pages contain half-tone illustrations and descriptions of the different types of punches, shears, bending machines, welding machines, horizontal bending and forming machines, riveting machines, helve and drop hammers and bending rolls made by this company.

THE PROPER CARE OF BELTS.—This is a booklet of 24 pages published by the Joseph Dixon Crucible Company, Jersey City, N. J. It is divided into three sections—Belts, Belt Dressings and Hints, Kinks, Tables. The first section deals with the running condition of belts; the second takes up treatment with various preparations; and the third, as the title indicates, has some general points upon belting and its use. This last section gives the economic speeds at which leather belts should be run; has some matter concerning the different styles of joints, illustrating three methods of leather lacing; contains rules for calculating speed of pulleys; gives horse power transmitted by various sizes of single and double belts, etc.

CAR WINDOW FIXTURES.—It is a rather difficult matter to illustrate clearly the design and operation of window fixtures. The Grip Nut Company, Old Colony Building, Chicago, Ill., has, however, succeeded in doing this in a very satisfactory manner in its window fixture catalog No. 17. The construction of the Universal window fixtures is splendidly shown in detail by means of colored plates. In addition to describing these fixtures and their advantages in detail, a clever arrangement has been devised by which it is possible to furnish the inquirer with exact information as to the fixtures to suit any conditions, so that definite specifications may be drawn up which admit of no misunderstanding.

WATER GLASS GUARD.—Under the caption of "Lawsuits and Accidents Prevented," the American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass., is sending out a folder describing the "Positive" water glass guard and considering its advantages. This guard consists of two frames or doors of malleable iron swinging on hinges attached to a bracket secured to the boiler head by studs. The doors completely cover the water glass and stand at such an angle with the boiler head that the light is reflected through sight glasses. The sight glasses are made of heavy plate glass with woven wire insert, and placed in slots in each door directly in front of the water glass, giving a perfect view of the water level at all times.

BAKER-PILLIOD VALVE GEAR.—The Pilliod Company, with a general sales office at 1545 Old Colony Building, Chicago, Ill., and the main office and factory at Swanton, Ohio, is issuing an attractive catalog under the title of "A Few Facts." It presents a carefully prepared and well illustrated detail description of the valve gear including drawings of each of the parts with data as to their weights. Then follows a statement of the claims made for the gear and the proof in the shape of indicator cards, valve motion reports and tests. A number of locomotives equipped with the gear are illustrated, including a consolidation type and a Pacific type on the Chicago & Alton, an Atlantic type on the Chicago & Northwestern, a Pacific type on the Central of Georgia, a Prairie type on the Chicago & Great Western and a ten-wheel type on the Toledo, St. Louis & Western.

NOTES

COMMONWEALTH STEEL COMPANY.—Boone V. H. Johnson, who for the past two years has represented the Scullin-Gallagher Iron & Steel Company in St. Louis, has resigned to accept a vice-presidency of the Commonwealth Steel Company.

CROCKER-WHEELER COMPANY.—At a meeting of the directors in July, Dr. Schuyler Skaats Wheeler was re-elected president, and the following officers were elected for ensuing year: Vice-president, Gano Dunn; 2nd vice-president, A. L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder; treasurer, W. L. Brownell; assistant treasurer, G. W. Bower.

THE BARNEY & SMITH CAR COMPANY.—Hugh M. Wilson, formerly editor and publisher of *The Railway Age*, will, on August 1st, become associated with this company, at Dayton, Ohio, of which he has been elected a director and a vice-president. Mr. Wilson disposed of his publishing business over a year ago and has only recently returned to the United States after nearly a year spent in foreign travel.

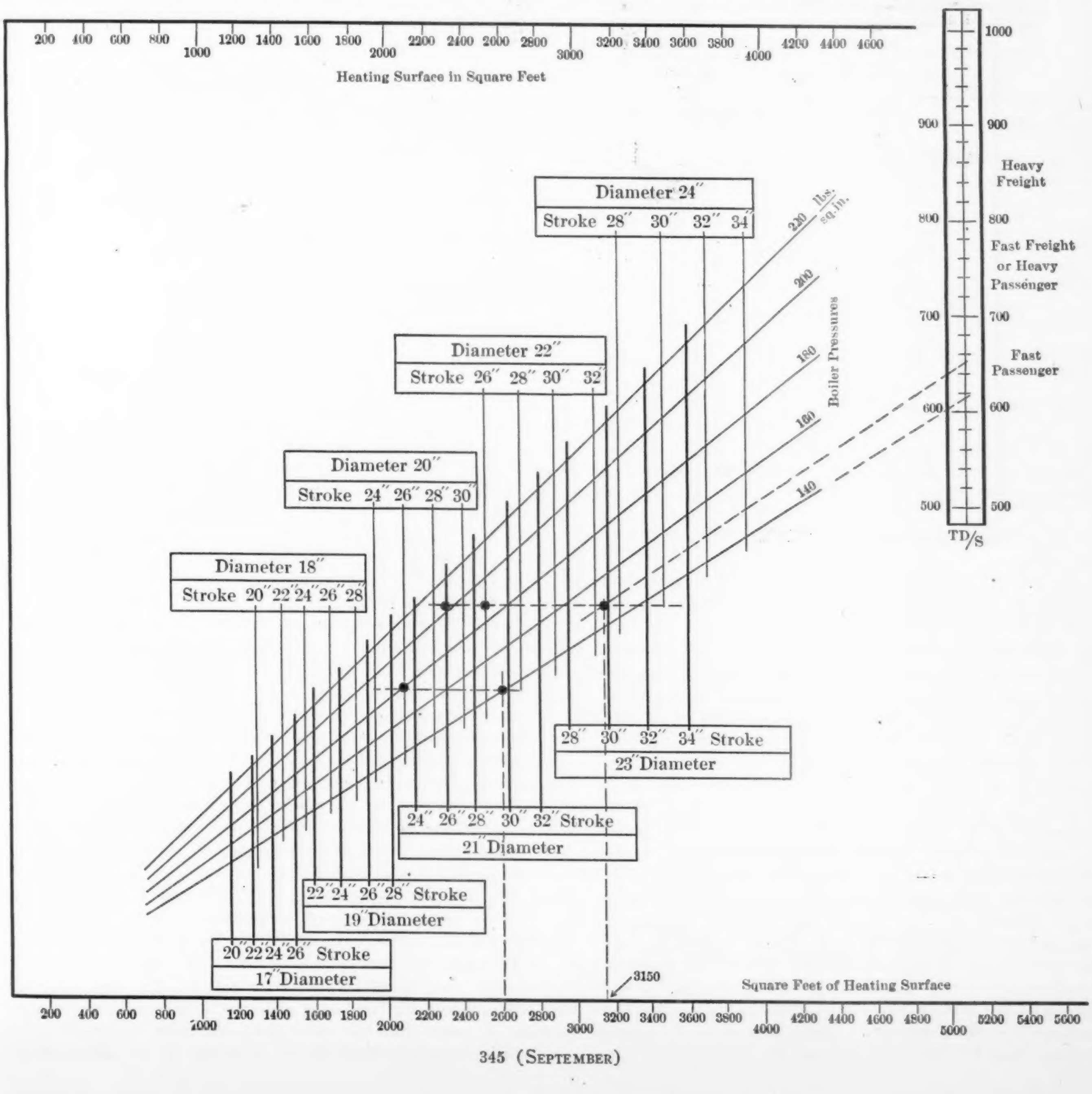
A DIAGRAM FOR DETERMINING THE RELATION BETWEEN CYLINDER POWER AND HEATING SURFACE.

Lawford H. Fry.

In any study of locomotive proportions it is necessary to have some method of measuring the relation between the cylinder dimensions and the boiler heating surface, that is, between the dimension which governs the steam consumption and the dimension which governs the steam production. The present writer has pointed out on several occasions in the American Engineer that a simple and efficacious method of measuring this relation is to determine the value of the factor TD ÷ S, that is, the Maximum Tractive Effort (T) multiplied by the Driving Wheel Diameter (D) and divided by the Total Heating Surface (S), the dimensions being respectively in pounds, inches and square feet. It has been shown (American Engineer, October, 1907) that this factor is proportional to the number of foot-pounds of work developed per square foot of heating surface during each revolution when the engine is working at maximum power.

The diagram herewith has been designed to afford a simple means of determining the value of the factor TD ÷ S for any combination of cylinder dimension and heating surface. It will be seen that there are a number of vertical lines grouped to represent cylinders of various diameters and strokes, and across these run diagonal lines corresponding to various boiler pressures. The first operation is to find the intersection of the vertical and diagonal corresponding to the cylinder and boiler pressure under consideration. A circle indicates, for example, the point corresponding to cylinders 20 x 26 with 180 pounds per square inch pressure. Through the point thus found a horizontal line is drawn, and its intersection with the vertical corresponding to the heating surface is noted. Through this second intersection point a diagonal is drawn from the origin. This diagonal will show, on the scale at the upper right hand corner of the figure, the value of the factor TD ÷ S.

It is found from a study of American practice that the usual values of the factor TD ÷ S run from about 620 to 850, the lower values corresponding to locomotives for high speed service, and the high values to heavy slow speed engines. This enables the diagram to be used to determine the cylinder dimensions suitable for a given service. Suppose, for example, that in high speed service an engine is to develop 1,400 horse-power



and that we can count on about 0.46 horse-power per square foot of heating surface. The total heating surface required will be about 3,150 square feet, and a value of 650 may be assumed for the factor TD ÷ S. A vertical is drawn to correspond to 3,150 square feet and a diagonal from the origin through 650 on the TD ÷ S scale, and a horizontal drawn through the intersection. This horizontal will indicate the cylinder dimensions which fulfil the conditions, and in the case chosen we have a choice between 21 x 26 cylinders with 200 pounds pressure or 22 x 26 cylinders with 190 pounds pressure. Of course, large cylinders and lower pressures will give the same proportions, but would hardly be likely to be chosen in practice.

If the diagram is to be used frequently it should be mounted with a thread attached at the center so that it can be used to draw the diagonal to the TD ÷ S scale; or an even better plan is to mount a transparent celluloid arm to pivot about the origin, drawing a line along the arm from the origin.

WEIGHING COAL FOR LOCOMOTIVES.

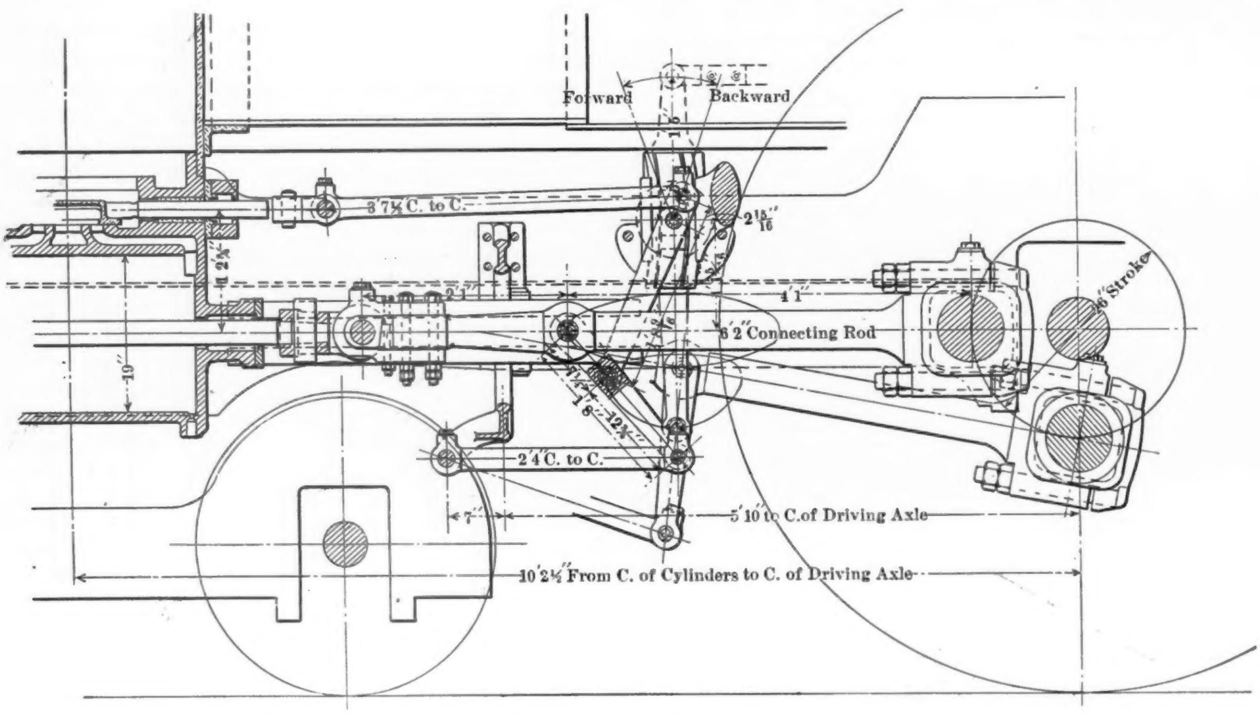
"It will be conceded that the most difficult side of the transactions is to obtain reports of the actual disbursements, as it is well known that this information is arrived at by most all roads on practically an estimated basis, on either the figured capacity of a coal bucket or other conveyance. It is found, however, from experience and actual test that the men in charge of coaling trestles become quite efficient in arriving at approximate actual figures of the number of tons of coal placed on each engine. From the number of engines that are coaled each day and from the fact that any discrepancies which exist at the close of the month are reported to him, he is receiving a training which fits him to be reasonably accurate in his daily records.

"Some roads have experimented with various devices for getting at the actual weight of coal placed on an engine. Such experimenting, it is believed, has been expensive and the results not permanent. It is a question, therefore, whether the expense involved in an endeavor to secure and use such a device would be in proportion to any better final results. It is thought, however, that the results which would be thus brought about could not vary from the results obtained from the system that has been outlined."—*From a Report on "Best Method of Accounting for Railway Fuel," to The International Ry. Fuel Assn.*

JOY VALVE GEAR ON LOCOMOTIVES.

The Joy design of valve gear is of the radial type to which the Walschaert and Marshall designs belong, but differs from both of these in several important particulars. It has been used to some extent in marine practice both in this country and abroad, but has never met with much favor in locomotive practice except in England, where several companies have applied it to a number of locomotives, and one, the Lancashire & Yorkshire, to a very large proportion of its equipment. Practically its only use in this country on modern locomotive equipment has been in the case of a three-cylinder locomotive, where it is used for actuating the valve gear of the center cylinder.

This valve gear has all of the advantages of the Walschaert gear for locomotive use, and some features which make it more desirable than that type for this purpose. On the other hand, it has one primary fault, from a practical standpoint, that has been largely responsible for its non-adoption. This refers to the constant sliding of the block in the link, which presents an opportunity for rapid wear and lost motion at this important point, with a possible decided alteration in the valve events. The fact, however, that it has been for many years in successful operation on the Lancashire and Yorkshire Railway, being at present applied to over 1,000 locomotives, indicates that this difficulty can be overcome and the advantages of simplicity, constant lead, rapid opening and closing of the ports, which it offers can be taken advantage of.



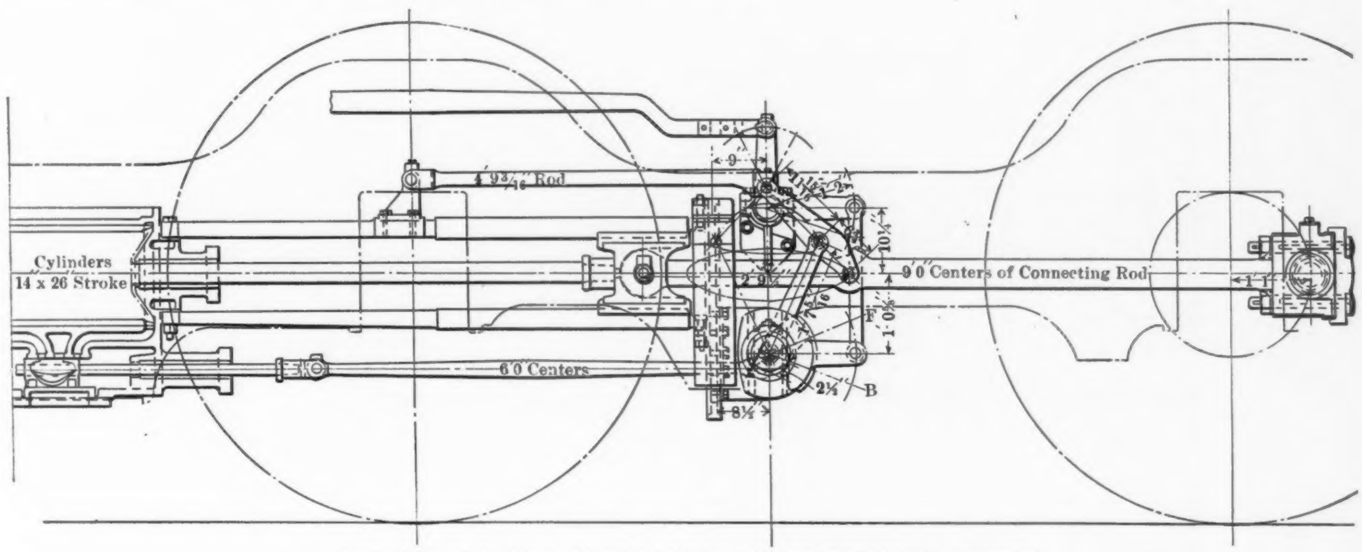
DESIGN OF JOY VALVE GEAR USED ON THE LANCASHIRE AND YORKSHIRE RAILWAY.

The illustrations show two arrangements of this valve gear in use on English railways, one being for a valve located below the cylinder and the other with the valve, in its customary American location, over the cylinder.

Referring to the Lancashire & Yorkshire design, it will be seen that the motion of the valve is all obtained from a connection on the main rod. A lever connected at this point has its lower end guided in a vertical arc by means of a link hinged to some stationary point, as the guide yoke. The upper end of this lever follows the path of an oval, symmetrical as regards the horizontal line, but slightly more pointed at the front end than the rear. The length of this oval is equal to the length of the piston stroke. Any point on this lever between the two connections will follow a distorted oval path and at a point, about one-third the distance from the main rod connection, is pinned a lever which extends upward and is connected at its upper end to a

radius bar hinged to the valve stem. Just below this upper connection is a pin carrying a block which slides in a link, the radius of which is equal to the length of the radius bar. When this link is set in a vertical or mid position the travel of the valve is equal to twice the lap plus twice the lead, the same as in the Walschaert gear in the mid position. The inclination of the link from the vertical determines the amount of travel of the valve and the occurrence of the valve events, since the block must of necessity travel a vertical distance approximately equal to the vertical length of the oval followed by the lower end of the connecting lever the path of which is shown in the illustration and a slight inclination of the link will thus increase its horizontal travel very materially.

On the Lancashire & Yorkshire, where this type of valve gear has probably had its most extensive use on locomotives, it is found that with engines identical in every respect except the valve gear, the mileage between repairs was greater and the coal consumption was less on those having the Joy valve gear and it is now specified as the standard valve gear for all new locomotives. When the gear was first introduced on this road the locomotives had cylinders 17½ x 26 in. and a working pressure of 160 lbs. and the same design was maintained and has been used on engines with 21½ in. cylinders and a pressure of 180 lbs. On larger locomotives, however, it was found that it was necessary to strengthen the pins and levers, which has now been done, although the same centers of links, etc., are still maintained. That road now has 1,004 out of 1,517 locomotives equipped with the Joy valve gear.



JOY VALVE GEAR USED ON THE LONDON AND SOUTHWESTERN RAILWAY.

BUYING COAL ON A HEAT VALUE BASIS.—The United States Geological Survey has just published a bulletin (No. 378) containing a discussion by John Shober Burrows on the "Results of Purchasing Coal Under Government Specifications." Among other things it describes the general plan followed and its advantages; the form of the specifications for both anthracite and bituminous coal are reproduced and a list of the contracts for the present fiscal year are given. The method of reducing the proposals to one common basis for comparison is also carefully described. Results of buying coal under these specifications for the fiscal year of 1907-8 are shown in a series of tables. The latter part of the bulletin, prepared by D. T. Randall, considers the "Burning of Small Sizes of Anthracite for Heat and Power Purposes."

HIGH SPEED DRILLS.—It is my experience that the high speed drill situation comes down to the question of which one will last the longest. Speed does not enter to any extent, as they will all stand a reasonably high speed without burning, but if they break too easily we quickly lose more than the equivalent saved on the output of work from the machine.—*A Foreman.*

BRIQUETS ON EUROPEAN RAILROADS.

Practically all of the European railroads use briquets and the quantity varies from 15 to 40 per cent. of the total coal consumed. The briquets for railway and steamship use are prismatic in shape. The French navy specifies 22-pound briquets. These briquets are broken before firing, and if well made will break into pieces without making dust. The railroads use briquets not to exceed 11 pounds in weight, which are fired one or more at a time by hand. Storage fuel is usually in the form of briquets; they are carried on the tanks along with coal and generally used to get up steam, to make up time, or over heavy grades during the run.

The specifications to contractors furnishing briquets to the state railroads on the continent are very rigid, particularly in France. These specifications vary somewhat in the different countries, but are covered generally by the following items:

1. Briquets shall be well made, sonorous, entire, with sharp edges, breaking with a clean cut, brilliant and homogeneous fracture.

2. Their cohesion shall be not less than 55 per cent. and they shall not soften at 50° C.

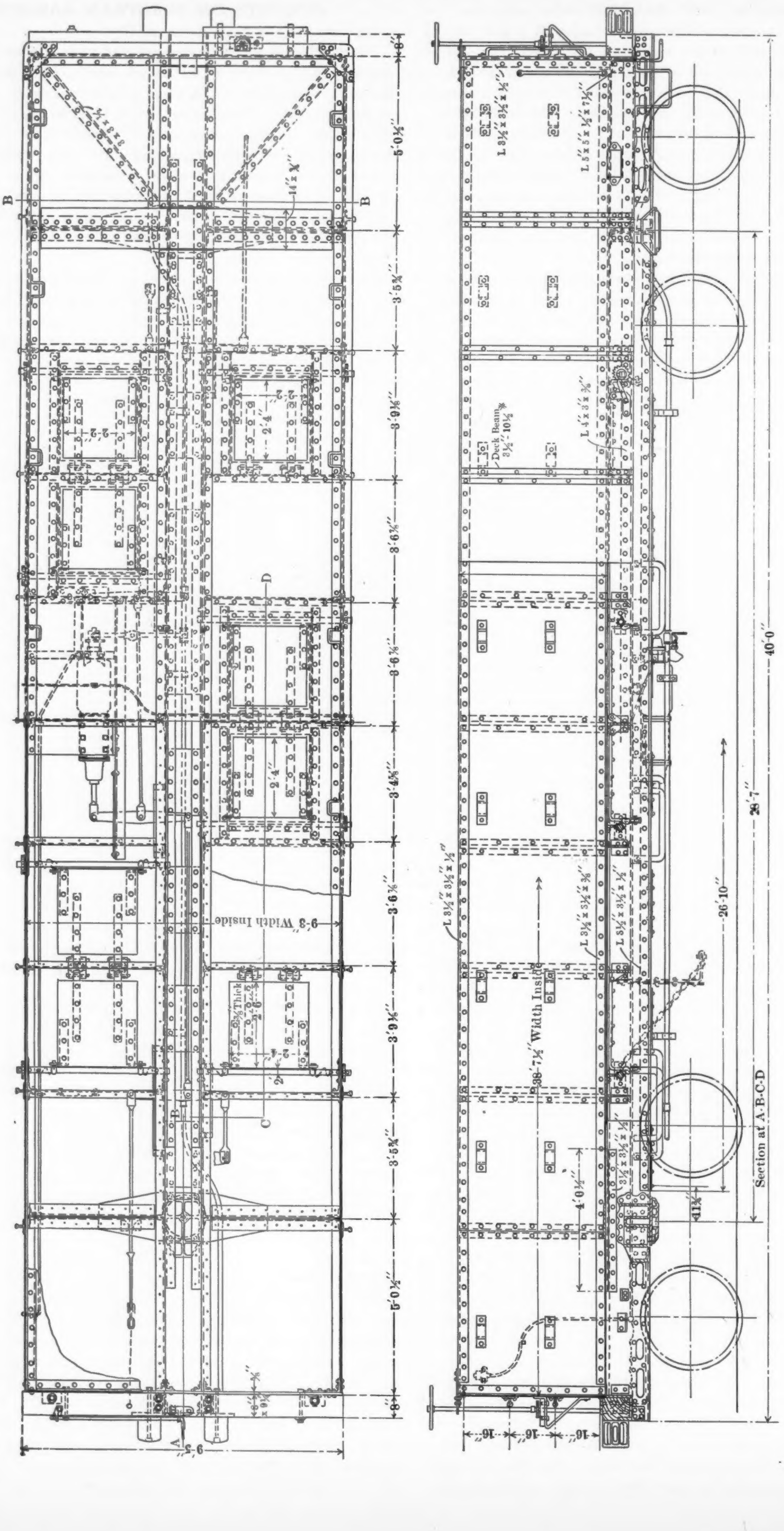
3. The briquets shall ignite easily without causing dense black smoke, shall burn with a quick bright flame and be consumed without disintegrating. The slag or clinker shall not adhere to the grates or tube sheets.

4. The briquets shall not be hygroscopic nor contain more than 4 per cent. moisture. They shall contain between 15 and 22 per cent. volatile combustible, and not more than 11 per cent. ash. The coal shall have been freshly mined and free from sulphur.

5. Coal tar pitch is the only binder specified; it must be practically odorless and limited to 10 per cent.

6. The briquets must be prismatic with a square base; when specified they are from 3 to 11 pounds in weight, according to kind of coal used, with a density of from 1.13 to 1.21.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

FIRE LOSSES IN UNITED STATES.—In the last five years, the total fire losses in buildings in the United States amounted to a billion and a quarter dollars. This was due mainly to the combustibility of the timber construction employed and might have been largely prevented by the use of suitable chemical fire-proofing compounds. In 1906, we spent $650,000,000 in building operations and the total cost of our fires was $500,000,000 and 6,000 human lives. In all the United States there are about twelve million buildings, in only about 8,000 of which has any serious attempt been made at fire prevention.—*M. T. Bogert, Presidential Address, American Chemical Society.*

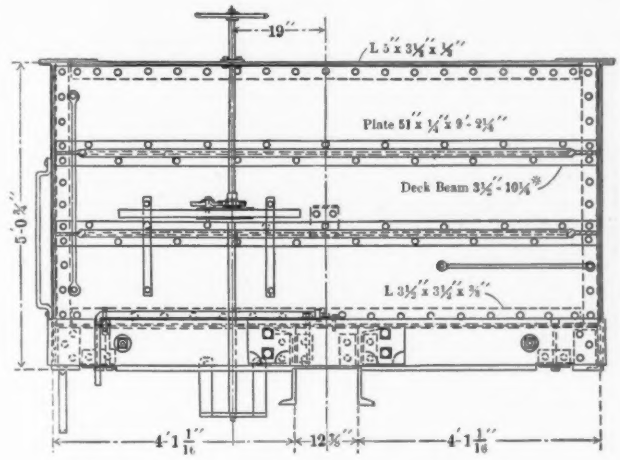


FIFTY-TON STEEL GONDOLA CAR WITH DROP DOORS—NORFOLK AND WESTERN RAILWAY.

FIFTY TON STEEL GONDOLA CAR

NORFOLK & WESTERN RAILWAY.

The Norfolk & Western Railway has recently designed a 50-ton steel gondola car, 300 of which are to be built at its Roanoke shops. Except for a few minor changes these cars will be similar to the sample car that has already been built, and which is shown in the accompanying drawings. While the sample car was under construction four drop doors were added, so as to allow for a greater discharge opening. To do this the location of the brake cylinder was changed slightly to admit of two doors being placed on that side of the car, while the additional

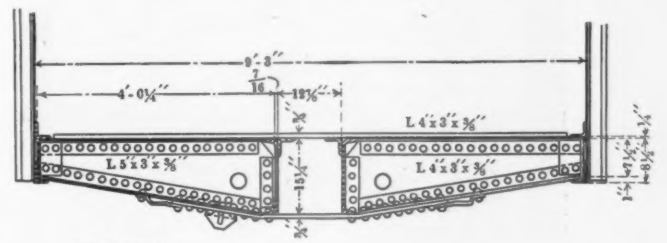


END ELEVATION OF 50-TON GONDOLA.

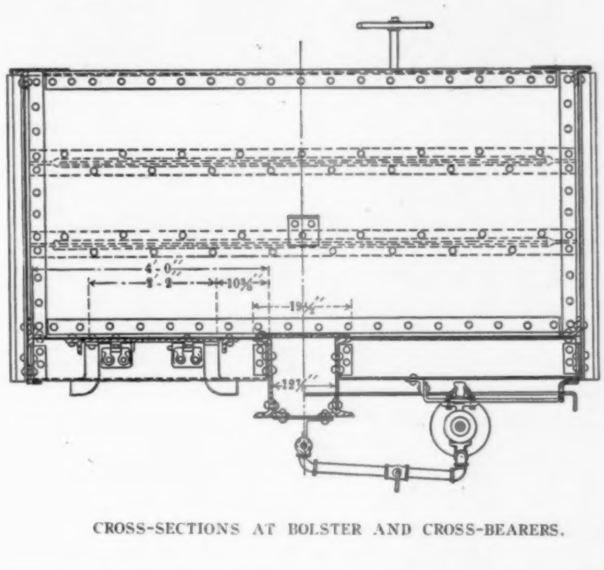
doors on the other side were placed at the center of the car. This makes the floor of the car unsymmetrical as far as the drop doors are concerned. The car measures 40 ft. over the end sills and has the following inside dimensions: Length, 38 ft. 7½ in.; width, 9 ft. 3 in., and height, 4 ft. 4 in. One-quarter-inch plates are used for the sides, ends and bottom of the car.

The stakes on the sample car were made of Carnegie tee section, but on the remaining cars will be made of 3½ in. deck beams, as it is much easier to drive rivets in the deck beams. The sides are reinforced at the top with 3½ x 3½ x ½-in. angles and at the bottom on the inside by 4 x 3 x ⅜-in. angles. In addition 3½ x 3½ x ⅜-in. angles are used for connecting the floor to the sides. The ends are stiffened by 5 x 3½ x ½-in. angles at the top and by two deck beams, as shown.

The center sills are 15-in., 33-lb., channels, with a top cover plate 5/16 in. thick. They are reinforced at the bottom between the bolsters by 3½ x 3½ x ½-in. angles. It will be seen that where the top cover plate is cut away at the bolster the sills are reinforced at the top by 3½ x 3½ x ⅜ in. angles. The body bolster is built up of plates and angles, with a heavy casting between the center sills. The cover plate of the bolster is ¾ of an inch thick by 14 in. wide; the bottom plate is of the same thickness, but only extends up about half-way between the center and the side sills. The bolsters have been made especially



Section at B-B

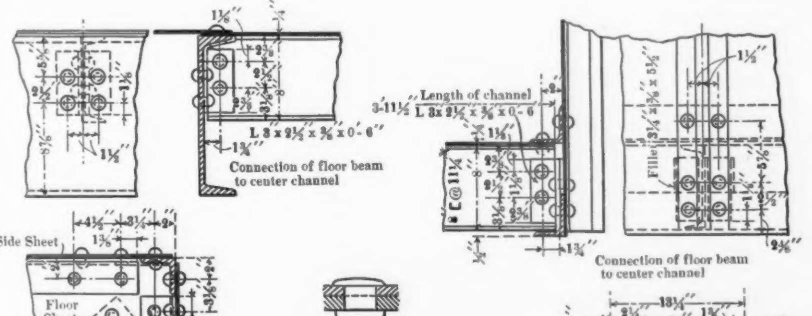


CROSS-SECTIONS AT BOLSTER AND CROSS-BEARERS.

strong, as it is expected that the major portion of the load will be transmitted to them through the deep plate girders which form the sides of the car and which, owing to their stiffness, will probably carry the larger part of the load. The floor stiffeners between the center and side sills are channels, fastened to them by angle plates.

In the cars that are to be built there will be some minor changes in the rivet spacing to more readily suit the multiple punches; also in the location of some of the handholds, brake staffs and stake pockets to facilitate handling the material in the course of manufacture.

Among the specialties that will be used are Session's draft gears, Farlow draft attachments, Westinghouse air brakes; cast steel truck bolsters, Andrews cast steel side frames and Plastic bronze journal bearings. A portion of the cars will also be equipped with Kensington journal boxes. These cars will be known as class GJ and were designed by the railroad under the direction of W. H. Lewis, superintendent of motive power, and John A. Pilcher, mechanical engineer.



STRUCTURAL DETAILS—N. & W. GONDOLA.

AN EFFICIENT FLUE PLANT.

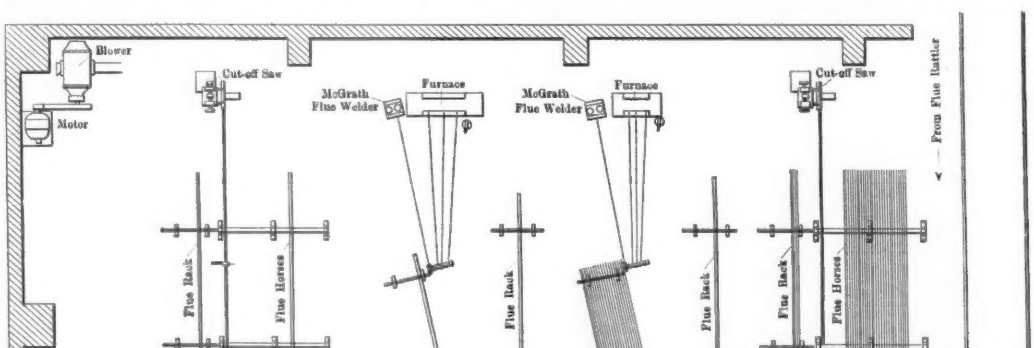
The horning, safe-ending, welding and swaging of 500 flues is considered an ordinary 9 hour day's work for two men, using but one furnace, in the flue department of the Lake Shore & Michigan Southern Railway shops at Collinwood. The general arrangement of this department is shown on one of the drawings. The flues are rattled and cleaned just outside the door to the right. They are then brought in and piled on the flue horses and the fag ends are cut off by the abrasion saw shown in the background, at the right, in the photo.

The construction of the abrasion cut-off saw is shown on one of the drawings. The cutting wheel is of tank steel 3/32 in. thick and 18½ in. in diameter. It is driven by a 10 h.p. motor through gearing and a belt drive, as shown, and revolves at the rate of 4,280 revolutions per minute. It cuts the flue by abrasion, doing it quickly and satisfactorily. The end of the flue is placed on the rest to the left of the wheel and revolves on the two rollers. The framework which supports the rest is forced inward, bringing the flue in contact with the cutting wheel, by admitting air into the cylinder which is made of a piece of 3¼ in. seamless brass tubing, No. 11, B.W.G., 12½ in. long. The air is controlled by the ½ in. cock. When pressure is removed from the lever which operates this cock it is brought back to its initial position, closing the cock and releasing the air, by the 9 in. coil spring attached to the frame of the machine and by the coil spring in the air cylinder.

As the fag ends are cut off the flues are piled in a rack from which they are transported by a traveling crane to the rack nearer the welding machine. The assistant welder picks the flue from this pile, heats it in the furnace, bells it on the horn and applies a safe-end. It is then placed in the center hole of the furnace, retaining the heat left in it after horning. The welder places it in the extreme left hole—the one nearest the hammer—and after bringing it to a welding heat, welds it in a McGrath welder, and while still hot swages it to the proper size. The flue is rolled backward and slides into a rack. The details of the front of this rack with the rollers which support the ends of the flues while they are being worked is shown on one of the drawings; also the roller and the guide at the edge of the rack which guide the flues to place when they are finished. The rear end of the flue rack is similar to the front part, except that there are no rollers and it is backed up by a ¼ in. plate to keep the flues from sliding too far backward.

The duplicate set of machines and apparatus at the left is used at times when an increased output is necessary. It is also used for 2¼ in. flues and for stationary boiler flues for outside points.

PARTIAL VIEW OF FLUE HANDLING PLANT AT COLLINWOOD SHOPS.



PLAN OF FLUE HANDLING PLANT AT COLLINWOOD SHOPS.

Leaky Gasolene Tanks.—These can be temporarily repaired by the use of common yellow soap. Gasolene will not affect soap and if the latter is merely pressed into a leak the opening will be effectually closed. In the absence of shellac, soap is good to use in making up gasolene-pipe joints.—*Nautical Gazette.*

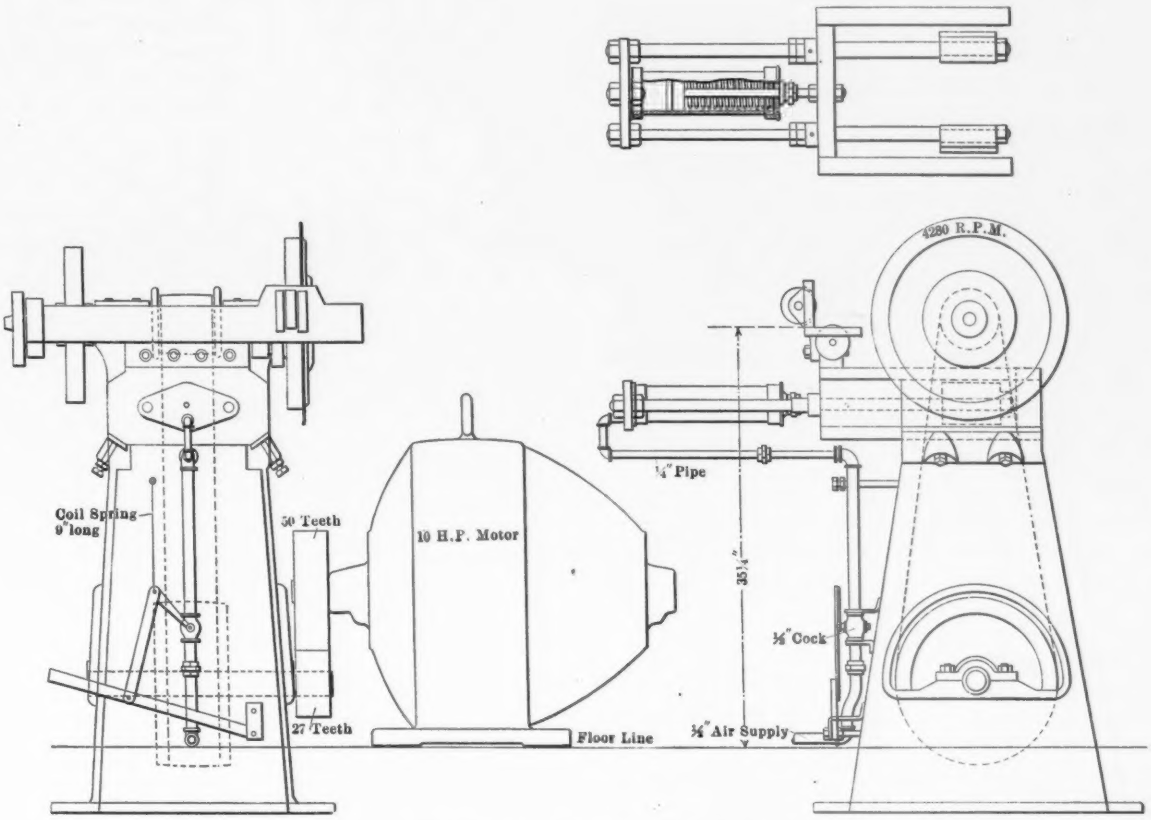
HOW TO SUCCESSFULLY BURN COAL IN A LOCOMOTIVE.

T. E. Adams, superintendent motive power of the St. Louis & Southwestern Railway (Cotton Belt) presented a paper on this subject before The International Railway Fuel Association, from which the following extracts are taken:

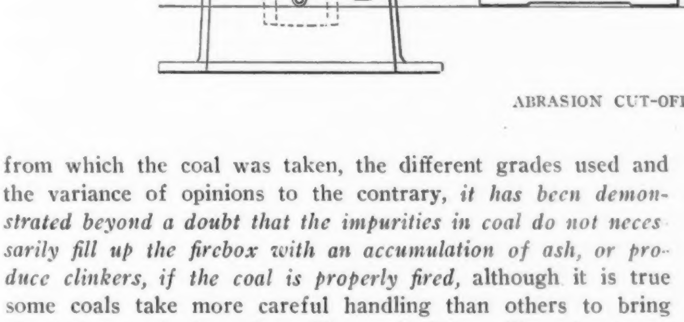
"It has been my privilege in the past twenty-five years, during a scientific and practical investigation of the coal question, to use coal from the following States: Pennsylvania, Ohio, Indiana, Illinois, Kentucky, Tennessee, Arkansas, Oklahoma, Iowa, Montana and Washington; and notwithstanding the wide territory from which the coal was taken, the different grades used and the variance of opinions to the contrary, *it has been demonstrated beyond a doubt that the impurities in coal do not necessarily fill up the firebox with an accumulation of ash, or produce clinkers, if the coal is properly fired,* although it is true some coals take more careful handling than others to bring about the required results. These principles will apply to any of the fuel coals now in use.

It may be of interest to the members of this association to have me in a few words outline our policy. The first important step that was taken in my own experience as a locomotive engineer was to eliminate under all conditions the excuse of "poor coal," the character of the coal not being considered. I consider this the first step in the line of progress, and this, with other important methods, has been followed up to the present time and it is unnecessary for me to say that the improvements made on the line with which I am associated are a great source of satisfaction not only to the management but to the enginemen in general.

The clinkering of coal is due to the manner in which it is handled and not to the quality of the coal. It therefore must be understood by foremen in charge of engineers, hostlers, etc., that they must understand the principles upon which the desired results may be obtained. At the several different places where switch engines are in use the business requires that they run continuously day and night, and if the engines come on the cinder pit with badly clinkered fires it causes serious delay to have them cleaned. In order to avoid this, it is necessary for engineers and firemen to understand that if the proper depth of fire is established on the grate when the fire is new, it will not be clinkered from this cause. Enginemen should be instructed that fires must not be shaken, when the fire is light, to prevent clinkering.



ABRASION CUT-OFF SAW FOR FLUES.



RACK FOR FLUES.

Engineers, hostlers, firemen, etc., should all understand that when an engine has run an unusual length of time without the fire being cleaned and the idea of not shaking grates has been carried out and the firebox has become filled with ashes and more or less unburned coal, it does not necessarily demonstrate that the fire is in bad condition and should be cleaned, but on the other hand it should be shaken down to a depth of eight or ten inches, ash pan cleaned and the engine continued in service; and if the matter is handled in this way the condition of the fire on the grates will be much better than if it had all been cleaned out and a new fire established.

If the weather is at freezing point or colder, and the train is an unusually heavy one in freight or passenger service, they should understand the necessity of building the fire on the grate surface so that the required steam pressure will be maintained.

In case after leaving the terminal, when the fire has been prepared in the manner suggested, the engine does not steam freely, grates should not be shaken for the reason that there is more liability of fire on grates not being heavy enough to main-

tain the required steam pressure, or possibly not being spread over the entire grate surface, such as front corners and under flue sheets, etc. If the grates were shaken it would have the effect of rather increasing the difficulties instead of overcoming them.

Enginemen should understand the importance of these instructions, as they are the fundamental principles of the art of firing, which have been demonstrated beyond a doubt: that where an engine lags for steam it is due to the condition of the fire in the box and in almost every case the fire is either not distributed properly over the grate surface or it is entirely too light to suit the condition under which the engine is to be worked. The principal thing to be understood in developing steam in a boiler freely is that the fire on grate surface must be maintained so that the air passing through it will be heated to a proper temperature.

THE HANDLING OF LUMBER IN THE YARD.

The following notes are taken from a paper on the treatment and handling of lumber presented by Hermann Von Schrenk before the Railway Storekeepers' Association: "Knowing that lumber is liable to check, warp, twist and rot, the question is how should it be handled in order to prevent these changes and to get it into the best possible condition for storage. The most important item is to dry the lumber evenly and as quickly as possible. This is done generally in the yard, and I now propose to devote a few minutes to the establishing of a yard and the manner in which lumber should be piled in order to dry it to the best advantage.

"Before placing lumber in a yard, as level a tract of ground as can be found should be selected. This should be well drained, and wherever possible, should be covered with some inert ballasting substance, preferably cinders, so that the growth of grass and weeds may be prevented as far as possible. All rubbish in the shape of old sticks, etc., should be carefully removed and kept removed. The ideal yard is the clean yard, and it is in such a yard that the best and least defective lumber is found. In laying out the yard a series of alleys should be planned, and wherever possible, these should be so constructed that the alleys run in the direction of the prevailing winds, and not at right angles to the prevailing winds, as is frequently the case. The yard should then be divided into a portion for piling, another for ties, stringers, caps, sills, etc., and another for building lumber, etc. In other words, the different classes of material should be kept separate as far as possible. Not only is this important because of the different kinds of woods used, and the different kinds of material, but it also facilitates counting and keeps the yard in a better condition.

"All material should be piled on permanent foundations. These foundations should, as far as possible, be decay-proof. In all of the tie and lumber yards recently constructed on the Rock Island and Frisco, we use nothing but creosoted stringers. We used for this purpose culled ties or culled bridge material, which was not fit for track use or for bridge construction. We treat these cull ties in the treating plants and lay them on the ground. This keeps the new material off the ground and renders any infection impossible. We put some of these creosoted stringers on the ground and then one pile across these stringers. The important part is that no untreated material is in contact with the ground. Instead of using creosoted stringers, one can make use of pecky cypress, which in the Southern States has been found to be one of the most valuable and essential timbers for this purpose.

"In laying out the yard attention should be given to the matter of fire protection. In addition to the longitudinal alleys, frequent alleys at right angles should be left, and these likewise should be permanent. It is far better not only from the standpoint of fire protection, but also for drying purposes to build small individual piles of all classes of material, than to bunch it in large piles where the fire danger would be greater and the drying more uneven. In our tie yards we are now building small piles both of ties and piling and also lumber. Between each pile we are leaving a space of at least four feet, and these spaces extend clear across the yard. We mark the rails of the standard and narrow gauge tracks, which extend up the longitudinal alleys, with paint, so that we know where the center of each pile is located and where the alleys are. When one pile of material has been used, the stringers are left on the ground, and when new material comes in, it is placed on the old stringers in exactly the same position in the yard. This insures permanency in the construction of the yard, and I can assure you that we are finding it of the utmost advantage. After the yard has been laid out, we are ready to pile the material. Certain general principles will apply to all classes of material; that is, ties, lumber, stringers, piling, etc. Remembering that we wish to get rapid and even drying, and remembering furthermore that where two timbers touch a weak place will be created where the fungi will flourish, it will readily be seen that the first principle in piling is to construct piles which are as open to air circulation as possible, and where the individual pieces will be in contact with one another to the minimum degree. The subject is too large a one for me to give specific directions as to the piling of the different kinds of material, because slight variations are necessary, depending upon the kind of timber and the climatic conditions involved.

"In spite of the most careful planning, however, some pieces of the timber will split and check. I have for years been recommending the use of S-irons for all classes of material. These are extensively used abroad and to some extent in this country. They consist of bevel strips of iron bent in the shape of the letter S. These are driven in at right angles to the check which is just beginning to form. As these S-irons are very cheap they ought to be used much more extensively.

"A well run yard is one in which great care and attention is paid, not only to keeping the material properly piled, but where all defective material is removed and destroyed. Pieces of wood lying around on the ground are constant sources of serious infection for the good material. Any expense incurred in keeping the yard clean is the cheapest kind of investment. I always insist that inspectors in lumber yards must have microscopic vision, that is, they must realize constantly that fungus spores are everywhere present in the atmosphere in countless millions, and are ever ready to pounce upon material at every favorable opportunity. We try to train our inspectors to recognize their greatest enemy in a punk or toadstool on a piece of material, and I think most of them realize by this time that the rubbing off of such punk or toadstool by no means lessens the danger, because new fungus will grow out from the same spot in short order, and the only way to get rid of the infection is to remove the diseased stick.

"Summing up the foregoing, please to note that lumber is liable to decay, warp, check, etc., that the object of putting lumber into a yard is to dry it so as to get it into fit condition for use, and at the same time to get it into a condition where it can be kept. In order to do so you must build a yard where all the conditions are such that the lumber can dry out evenly and quickly and remain free from infection. This means care in the construction of the yard, drainage, ballasting, and above all, cleanliness."

RAILROAD Y. M. C. A.—There are now 245 associations, which own 178 buildings worth $3,569,200. These figures are constantly increasing. In 1907 and 1908 there were twenty-six new buildings erected at a cost of over $750,000. On the New York Central Lines there are forty associations. On the Pennsylvania Lines, East and West, there are thirty-six. The Grand Trunk Railroad has fourteen; the Boston and Maine, ten; the Chesapeake and Ohio, nine; the Norfolk and Western, eight; the Gould lines count twenty-seven among its valuable items of successful operating features. One or more branches are on as many as sixty-three different railroad lines throughout the United States and Canada.—*H. O. Williams before the Richmond Railroad Club.*

HEAT AND WATER CONSERVING SYSTEMS FOR CLEANING AND WASHING OUT BOILERS

J. E. EPLER.

Water in a locomotive boiler becomes foul or dirty as continued evaporation concentrates the impurities fed in with the feed water. As a result boiler washing and refilling is necessary at intervals varying with the amount of impurities in the feed water.

Cold water may be used for washing and filling though a liberal supply of hot water is much better, as by its use boilers can be emptied, washed and filled without causing destructive cooling and expanding strains. Terminal delays are reduced 2½ to 3 hours when washing out and washouts are materially less in number, as frequent water changes take their place. Changing water in a locomotive boiler may be accomplished in less than two hours and engines can always leave the house with clean water in them, thus reducing delays on the road due to foaming.

A thorough and careful washing with cold water proceeds about as follows:

Boiler is cooled down by feeding cold water into it, requiring, 15,000 gal. water, 1½ hr.
Boiler is emptied...½ hr.
Boiler washing gang removes plugs, washes boiler and replaces plugs, 2,000 gal. water, 2 hr.
Boiler is filled with cold water........................3,000 gal. water, ¼ hr.
Fire is built and steam pressure raised to working point....2 tons coal, 2hr.

Total ....20,000 gal. water, 6¼ hr. 2 tons coal

The possible savings by using hot water for washing and filling are:

No cooling necessary, thus saving................15,000 gal. water, 1½ hr.
Actual operation of washing can be accomplished with less water in less time, saving................................1,000 gal. water, 1 hr.
Coal for firing up and time required reduced by..........1 ton coal, 1½ hr.

Total.............................16,000 gal. water, 3½ hr., 1 ton coal

The value of hot feed and wash water is sufficient to warrant the burning of fresh coal to produce it. If, however, the heat, ordinarily thrown away when an engine is cooled down and emptied, is saved, it will be sufficient to heat the water used for refilling, and the dirty water, after imparting a part of its heat to the fresh feed water, is itself available and satisfactory for washing out purposes.

Methods of Saving Heat.

The methods in common use for saving the heat in the boilers of incoming engines so that it may be used in the boilers of outgoing engines are as follows:

First—Discharging the contents of the boilers of incoming engines into a hot well.

Second—Condensing the steam rising from the foul water blown off from incoming engines by bringing it in direct contact with sheets of fresh water flowing over the trays or baffle plates of an open heater.

Third—Transferring the heat through the tubes or coils of a heater, the steam and water from incoming engines being blown through the heater on one side of the tubes and the fresh water to be heated passing through the heater on the other side.

HOT WELL RECEIVING STEAM AND WATER.

The simplest method is to blow the entire contents of the boiler into a hot well. This is not very satisfactory, as the same foul water, partially diluted, will be pumped back into the engine when re-filling. The water lost in leakage and that used for washing must, of course, be replaced by fresh water in the well.

When this method is used connection must be made to the blow-off cock and the boiler's contents are discharged into a pipe, encircling the roundhouse, which empties into the hot well.

Heat Available.—The saving of heat is the amount of heat in the water discharged when cooled down to 212 degrees. All of the heat above 212 degrees passes off from the hot well in the steam rising from its surface. This method would furnish the supply of wash and feed water at 212 degrees if it was not for radiation losses.

HOT WELL RECEIVING STEAM ONLY.

As the hot well receiving the entire contents of the boiler is not satisfactory because of using the same foul water over again the practice is sometimes followed of blowing the steam only into the hot well. When this is done it is customary to pipe the roundhouse so that connection is made at the dome of the engines to an overhead pipe which circles the house and discharges under the surface of the water in the hot well. This is inconvenient, as it it necessitates climbing up to the engine dome to connect and disconnect. After the engine has been blown down the water in it runs into the pit and thence to the sewer, a process which fills the roundhouse with steam, making it damp and unpleasant and also preventing the mechanics and others from getting at the machinery and running gear while the water is being emptied out.

Heat Available.—Most of the heat carried off in the steam is saved. The amount of this depends upon the boiler pressure, or the temperature of the boiler when blown off. If the engine commences to blow off at 100 lbs. pressure the temperature of the water in it is 337.8 degrees. Steam will pass off until the temperature of the water in the boiler reaches 212 degrees. A fair-sized locomotive boiler contains 3,000 gallons, or 25,000 lbs. of water. The heat saved by the above method would then be 25,000 multiplied by 125.8, or 3,145,000 B.T.U. With the initial temperature of the feed water at 65 degrees, this heat will raise 3,000 gallons, or one boiler full, to 190.8 degrees.

OPEN HEATER WITH TANK SEPARATOR.

Another method of obtaining hot water for filling and washing is to discharge the entire contents of incoming engines into a tank or separator from which the steam rises and goes to an open heater and the water in the separator is saved for washing purposes. This system is more desirable in the roundhouse than the system of blowing steam into the well, as the connection to the engine is made at the blow-off cock, a much more accessible point than the dome. The entire contents of the boiler are discharged through this connection into a pipe encircling the house which leads to the tank in which the steam separates from the water.

Heat Available.—This method is better than the simpler method of blowing the steam only into the hot well, as the hot water left in the separator is available for washing. The heat saving, however, is not as great as in the method where both steam and water are discharged into a well so constructed that radiation losses are small.

CLOSED HEATER.

With the closed heater the heat in the foul water is saved by transferring it through tubes or coils in which the foul water is on one side of the tubes and the fresh water to be heated is on the other side. In this system one connection is made to the engine at the blow-off cock by means of a flexible hose and the entire contents discharge into a pipe encircling the house and emptying into the heater. This method possesses all the advantages of the others, such as accessibility to the engine, dry roundhouses, etc. It also has a further advantage in that a greater amount of heat may be saved than with an open heater.

Any system using only the steam for heating can only use the heat given in cooling down to 212 degrees. A closed heater system can carry this cooling of the hot foul water to a much lower degree. In fact with a suitable design of heater, the transfer of heat can be carried on until the foul water is cooled down

to the temperature of the incoming feed water. The desirable point to stop, however, is at 130 degrees, about the maximum temperature the washout men can handle. After cooling down to 130 degrees by the transfer of the heat to the incoming feed the foul water is drained into a storage tank and is available for washout water without the necessity of adding cooling water to temper it to a point where the washout gang can handle it, as must be done with open heater systems which discharge the foul water into the washout storage tank at a temperature of 212 degrees.

Heat Available.—The amount of heat available for heating feed water with this system, assuming as before that the engine is blown off at 100 lbs. steam, or 337.8 degrees Fahr., and that the water blown off is cooled in the heater to 130 degrees is 207.8 B.T.U. per pound of water blown off. This will amount to 207.8 times 25,000, or 5,195,000 B.T.U., or more than enough to raise 3,000 gallons of feed water from 32 degrees to 212 degrees.

Tempering Water to Cool Wash Water.—With the open method the foul water goes to the wash storage tank at 212 degrees, necessitating cooling this 82 degrees by the introduction of cold water before it is at a temperature such that the boiler washers can handle it. This is an item of expense not necessary with a closed heater system which cools the foul water to wash water temperature in passing through the heater.

RESULTS AND COST OF INSTALLATION.

As to the cost of installation of these three methods. The first hot well is without doubt the cheapest to install. The last or closed heater is the most expensive and gives the best results, as it possesses all of the desirable features of the other two, and in addition is more economical as a heat conserving device.

At a roundhouse where 400 engines were handled per month a closed heater method showed $11.45 per day as the value of coal and water saved. This is $343.50 per month, or $5,322 per year. At this rate it is evident the saving will soon pay for the plant.

The other savings, such as quicker turning of power, increased life of fireboxes, reduced boilermaker wages, cleaner roundhouses, etc., are much greater than the saving in coal and water. These savings, though very real, are not easily reduced to dollars and cents.

WELDING BOILER TUBES TO THE TUBE SHEET.

TO THE EDITOR:—

Probably the most important factor in causing the bridge walls of the tube sheet to crack is the use of the flue expander or roller. In order to keep the joint tight, even with the use of copper ferrules, the metal of the flue sheet must be strained beyond its elastic limit next to the tube, and this process repeated many times causes incipient cracks, which under the stresses due to the heat of the furnace, ultimately results in the entire disruption of the metal between the tubes. The use of the expanding tools is rendered necessary because of leakage of the flues, and therefore if we are able to secure and maintain tight joints without the use of the expander, and without straining the metal at this point, it would seem that the life of the sheet would be increased, and the troubles due to leaking tubes obviated.

Since the oxy-acetylene process of welding has entered the railroad field, I have looked in vain for a description of the method of using this process to weld the tubes to the tube sheet. While radical, this seems to me to be entirely feasible, and I understand is being used at least experimentally at some points. In studying the subject I have evolved the following method of welding the tubes and propose a means of removing them when necessary on account of scale, which would leave the hole the exact size for the insertion of the new tube, and also prepared for the welding-in process, all in one operation.

Referring to the sketches, Fig. 1 shows the tube sheet with the hole drilled and the fire side counterbored at the desired angle (say 45 degrees) for about one-half the thickness of the plate, to allow clearance for the welding process. Fig. 2 shows the tube inserted, with the end flush with the fire side of the sheet. Fig. 3 represents the tube welded into the sheet, the dotted portion being the filled-in part of the weld. If properly done this should give a homogeneous structure throughout the welded portion, the surface of the tube and of the sheet being fused. This should prohibit all leakage at this point. It will be noted that there are no projections to be burned off by the furnace fire.

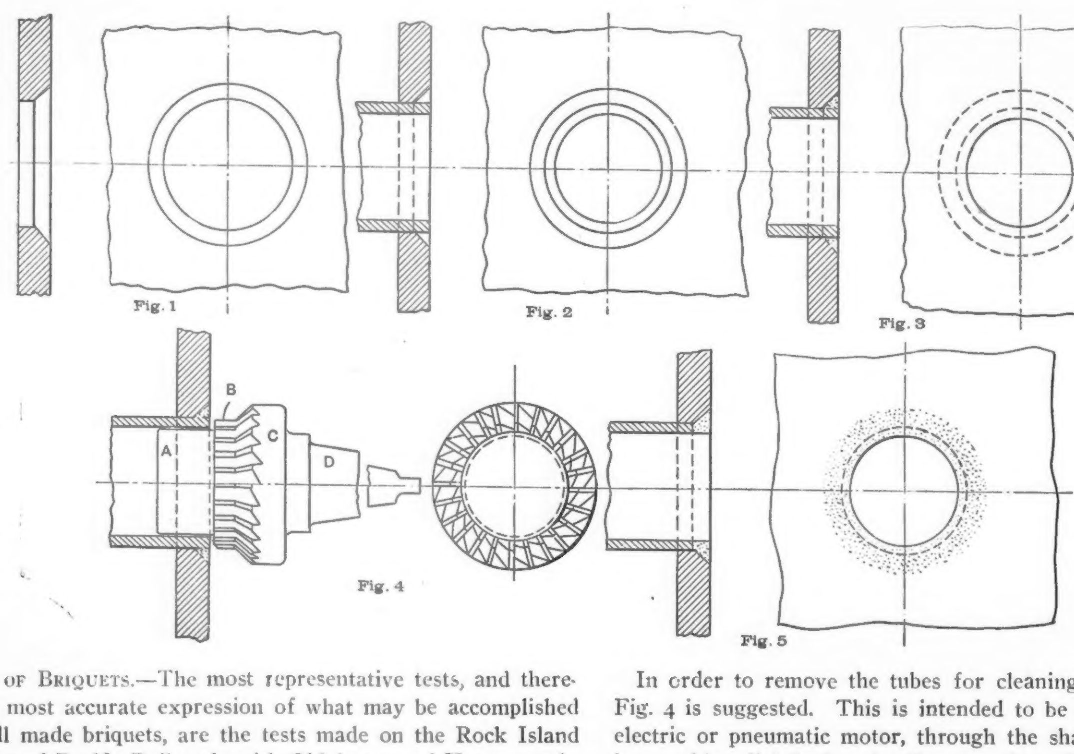


Fig. 1 Fig. 2 Fig. 3

Fig. 4 Fig. 5

TESTS OF BRIQUETS.—The most representative tests, and therefore the most accurate expression of what may be accomplished with well made briquets, are the tests made on the Rock Island and Missouri Pacific Railroads with Oklahoma and Kansas coals. The Rock Island tests show an increased equivalent evaporation of 8 per cent. and increased boiler efficiency of about 15 per cent., while the Kansas briquets show 25 per cent. increased evaporation and boiler efficiency over lump coal.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

In order to remove the tubes for cleaning, the tool shown in Fig. 4 is suggested. This is intended to be driven by either an electric or pneumatic motor, through the shank "D." Part "A" is a guide, slightly less in diameter than the internal diameter of the tube; "B" is an end reamer, the outside diameter of which is the same as the outside diameter of the tube, the difference in the diameters of "A" and "B" representing twice the thickness of the tube wall. The length of part "B" can be more than one-half the thickness of the tube sheet. Part "C" is a reamer

having a bevel that gives the desired counterbore to the tube sheet. A shank "D" provides means of driving the reamer. This tool can be made out of one piece if desired, or the sheet may be counterbored later by a separate tool.

Should difficulty be experienced in getting a good weld on the under side of the tube, as shown in Fig. 2, the method indicated in Fig. 5 may be used, where the tube is inserted only one-half way through the sheet, and metal added to complete the weld as indicated by the dotted portion. The same tool would be used to cut out this tube as though the previous method were used.

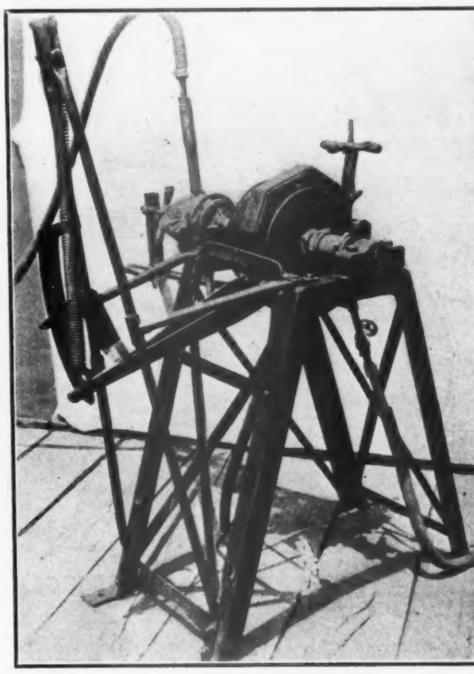
The writer would be glad to hear criticisms of the above method, or to learn of any case where the tubes have been welded-in.

J. W. RUPERT.

PORTABLE AIR MOTOR TESTING MACHINE.

A machine for testing pneumatic and small electric motors has been in use for about a year at the Mt. Clare shops of the Baltimore and Ohio Railroad and has proven to be of decided value in determining the capacity and economy of new motors as well as the condition of older equipment. By the courtesy of R. C. Powell, foreman of shop tools, we are able to give a photograph that shows the general arrangement and principle of the machine very clearly.

AIR MOTOR TESTING MACHINE—FRONT.



AIR MOTOR TESTING MACHINE—REAR.

It consists of a substantial framework supporting a shaft which carries a hollow cast iron wheel around which is fitted a prony brake. The movement of the brake arm is resisted by a long coiled spring and a scale, graduated in pounds and ounces, is provided for showing the tension on the spring. The revolutions are taken by a counter on the end of the shaft and the horse-power is thus easily obtained. The volume and pressure of air are accurately measured and the economy of the motors at different speeds are then derived. The brake wheel is arranged for water circulation to carry off the heat generated. The machine is so arranged as to be capable of testing any sized air drill which can be very quickly and easily put into place. It can be moved to different shops as desired or stowed where it will be out of the way when not in use.

New York Railroad Club.—At the September meeting Frederick C. Syze, of the Staten Island Rapid Transit Railway Company, will present a paper on "Surprise and Efficiency Tests of Employees Charged with the Operation of Trains."

POWER REQUIRED FOR TAPPING.

The accompanying table gives the results of experiments on the power required for tapping, covering nominal pipe tap sizes from 2 to 8 inches. The holes tapped were reamed with standard pipe tap reamers before tapping. The tests were made by the American Tool Works Company, of Cincinnati, on one of its radial drills.

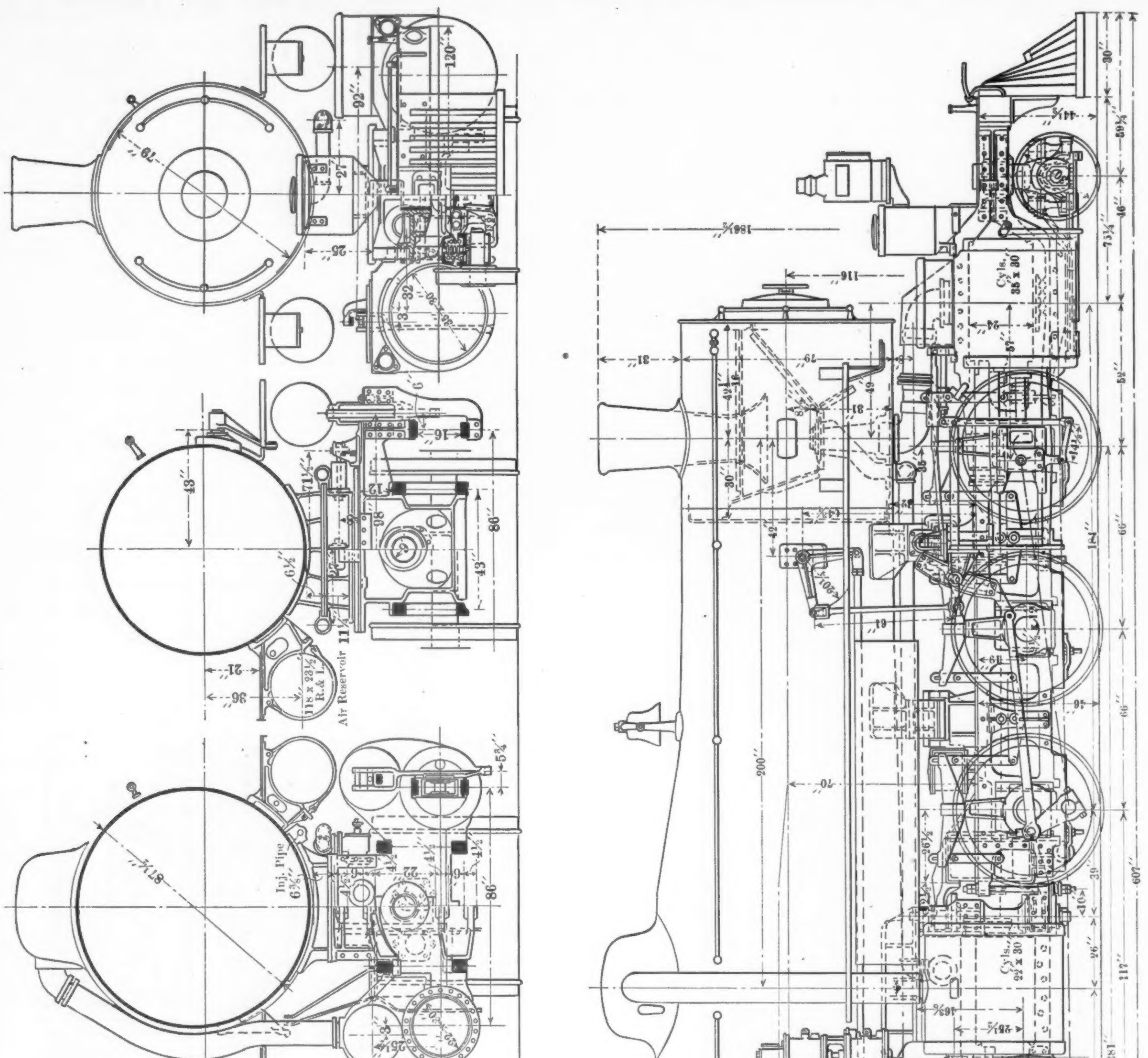
POWER REQUIRRD FOR TAPPING

Nominal Size of Pipe Tap, inches	Revo'utions per Minute	Net Horse-power	Thickness of Metal, Inches
2	40	4.24	1⅛
2¼	40	5.15	1⅛
*2½	38 5	9.14	1⅛
3	40	5.75	1⅛
*3	38 5	9.70	1⅛
3½	25 6	7.20	1¾
4	18	6.60	2
5	18	7.70	2
6	17.8	8.80	2
8	14	7.96	2½

* Tapping steel casting; other tests in cast iron.

The horse-power recorded was read off just before the tap was reversed. In the table, however, is given the net horse-power, deductions being made for the power required to run the drill without a load. The material tapped was cast iron, except in two instances, where a steel casting was tapped. It will be seen that nearly double the power is required for tapping the steel casting. The taps used were of the inserted blade type, the blades being made of high-speed steel.

SMOKE AND CINDERS FROM BRIQUETS.—The reduction in cinders and sparks by briquetting depends on the quality of the coal as well as the density of the briquets. Certain coals, like the Loydell coal, produce a fine scale of coke in burning which is often loosened from the surface of the briquet by the action of the draft and carried partially burnt through the stack. With Hartshorne and Arkansas coals the coking is much different in character, probably due to the higher ash content, and these coke scales are scarcely noticeable. The same difference was noticed in burning briquets made from Pocahontas coal and "bone coal" picked from the mine-run coal. The latter was high in ash and the scales were greatly reduced. The results at Altoona testing plant show no appreciable reduction in the weight of cinders from briquets, but a decided reduction in their calorific value.—*C. T. Malcolmson before The International Ry. Fuel Assn.*



ELEVATION AND SECTIONS OF MALLET ARTICULATED COMPOUND LOCOMOTIVE—2-6-6-0 TYPE—VIRGINIAN RAILWAY.

MALLET ARTICULATED COMPOUND LOCOMOTIVES, 2-6-6-0 TYPE, AND SWITCHING LOCOMOTIVES 0-8-0 TYPE.

Virginian Railway.

On page 261 of the June issue of this journal appeared a brief general description, with outline elevation, of a design of Mallet compound locomotive, four of which are being delivered by the American Locomotive Company to the Virginian Railway. These locomotives were designed under the direction of R. P. C. Sanderson, superintendent of motive power of the railway, and are the first of this wheel arrangement to be used in this country, although not the first to be constructed by the builders, who last year delivered an order to the Eastern Railway of France of the same type, although smaller in size.

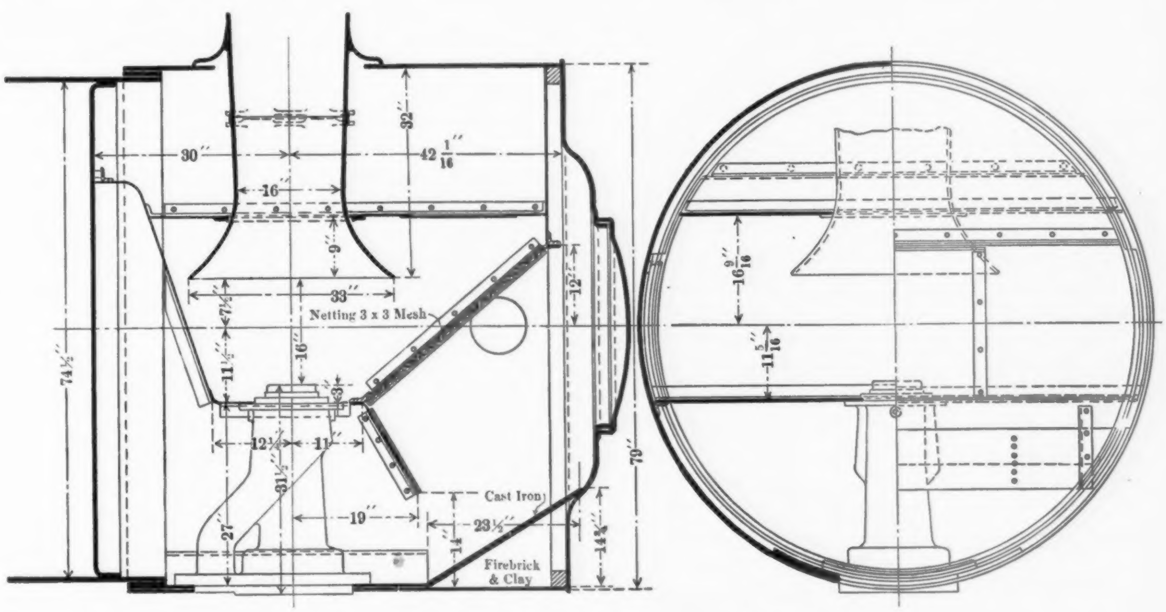
With the exception of the climb over the Allegheny Mountains, the ruling grade of the Virginian Railway, against the east-bound or loaded traffic, was placed at .2 per cent. compensated. There are places in the mountains where the grade rises to .6 per cent. and there are also other short stretches where it is slightly in excess of .2 per cent. For the purpose of handling traffic over sections in excess of .2 per cent. grade, the Mallet compound locomotives have been purchased.

stays at the front end of the crown and has liberal spaces in the water leg. There is but one fire door.

The arrangement of the diaphragm, deflector plates and netting at the front end is shown in one of the illustrations. It will be noticed that the smokestack has an unusually long extension inside of the front end.

Directly above the high pressure cylinders on the dome course, measuring 87½ in. outside diameter, is located the cast steel dome, which is very similar in design to that used on other Mallet articulated locomotives built by this company. It has an annular cavity extending around the front half of its circumference, which leads from the throttle pipe connection to the steam pipes extending down on either side to the top of the valve chambers of the high pressure cylinders. The throttle, which also acts as a steam separator, is very similar in design to that applied to the Erie Mallet.*

Differing from the usual practice, the throttle valve is operated through a system of levers by a crank arm on a horizontal shaft, passing out through a stuffing box in the side of the dome. The throttle lever is pivoted above the top of the backhead of the boiler.



SECTION THROUGH FRONT END—VIRGINIAN MALLET.

In working order the locomotive will have a total weight of 330,000 lbs., of which 312,000 lbs. is carried on drivers. The calculated tractive effort working compound is 70,800, which, however, can be increased about 20 per cent. by working the engine simple, giving a maximum tractive effort of nearly 85,000 lbs. The design includes the Mellin intercepting valve, which permits live steam to be admitted to the low pressure cylinders while at the same time diverting the exhaust in the high pressure cylinders through a separate pipe to the exhaust pipe in the smoke box, which is specially designed, as is shown in the illustration, to prevent the exhaust from the two points interfering with each other.

The general elevation shows the designs of the large extended wagon top type of boiler and the heating surface, etc., will be found in the table of general dimensions. This boiler contains no particular novelties, differing from customary practice principally in having a double check valve on the top center line of the front barrel sheet, which arrangement is used on other locomotives on this road, and in having the firebox crown and side sheets in one piece, as are also the outside and roof sheets. The fire box is radially stayed, with two rows of sling

The arrangement of steam pipes to the high-pressure cylinders and the design of the cylinders follows the usual practice for this type of engine. The high pressure cylinders, which are 22 inches in diameter by 30 inches in stroke, are cast in pairs with saddles and are separated at a point to the right of the center in order to provide room for the connection to the receiver pipe which extends along the center line of the engine.

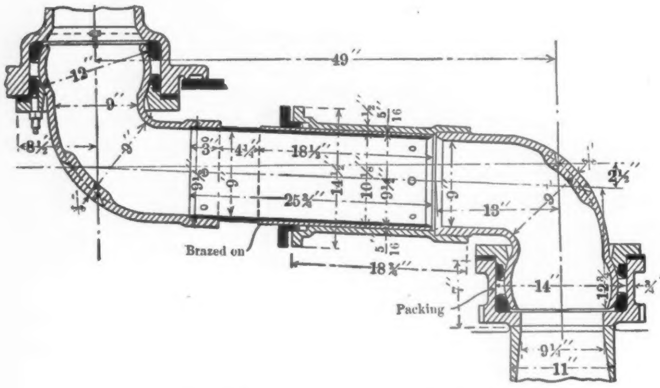
As before stated, the Mellin system of compounding is used, the intercepting valve being located in the left high pressure cylinder casting. The emergency exhaust valve is contained in a separate chamber attached to the side of the left cylinder casting and communicating with the intercepting valve. From the emergency exhaust valve, a 4½″ pipe, with universal joints, leads to the exhaust pipe in the smoke box. Exhaust steam from the right high pressure cylinder passes back through the casting into an outside U-shaped pipe connecting to a passage in the left cylinder casting, which leads up to the intercepting valve chamber into which steam from the left cylinder also exhausts. From the intercepting valve, it passes to the receiver pipe, leading to the low-pressure cylinders.

* See American Engineer, 1907, page 340.

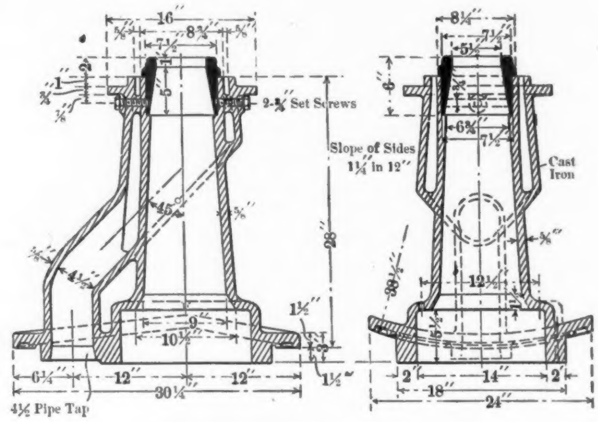
The receiver pipe has a ball joint connection with the high pressure cylinders and a slip joint at the front end where it connects to a Y-pipe, the branches of which connect to the cored passages in the low pressure cylinders.

Owing to the application of the leading truck and the consequent moving forward of the boiler, it was necessary to use a different arrangement of flexible connections between the low pressure cylinders and the exhaust nozzle from that employed by the builders in other engines of this type without a truck. The two exhaust passages from the cylinders come together in side admission, the eccentric crank thus leads the pin in each case. Reversing is effected by means of a hydropneumatic reversing device, the same as that used on the Mallet articulated compound built by this company for the Baltimore and Ohio R. R. The construction of the frames, which are of cast steel, and the arrangement of the articulated connection between the front and rear engines are also practically the same as in the Baltimore and Ohio engine.

The front truck is of the radial swinging bolster type, being suspended by three point or stable equilibrium hangers and the



FLEXIBLE EXHAUST CONNECTION.

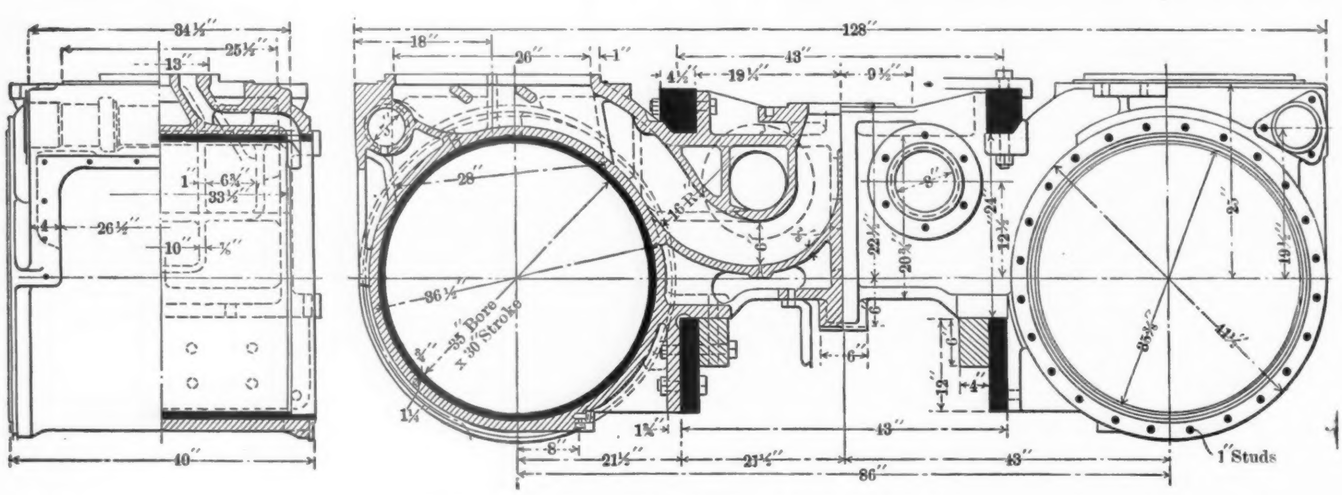


EXHAUST PIPE AND NOZZLE.

the center of the cylinder saddle, and fitted to the single opening in the top of the saddle is a cast iron flange which forms a stuffing box for the ball joint connection. The back end of the elbow screws into the front section of the connecting pipe leading to the exhaust pipe in the smoke box. The two sections of this pipe have a slip joint connection between them and the rear section is provided with an elbow which has a ball joint connection with the exhaust pipe in the smoke box. This combination of ball joints and slip joint thus permits the connecting pipe to adjust itself to any lateral or vertical movement of the low pressure cylinders relative to the smoke box.

Piston valves, having internal admission, are used on the high pressure cylinders, while the low pressure cylinders are pro- load is transmitted to the journal box by means of coiled springs seated on top of the box. This arrangement is shown in one of the illustrations. Because of the application of the truck, it was necessary in this design to use two self-adjusting sliding bearings to support the boiler on the front frames, both of which carry load under normal conditions. Each of these bearings is provided, as usual, with safety straps to prevent the frames from dropping away from the boiler in case of derailment, and the front bearing is provided with the builder's usual design of spring centering device.

Vertical bolts, connecting the upper rail of the front frame with the lower rail of the rear frame, are used to equalize the front and rear systems. But in this design the load on the bolt



LOW PRESSURE CYLINDERS SHOWING STEAM PASSAGES.

vided with Allen-ported slide valves, having external admission. Both valves have a maximum travel of 6 inches and are set for 3/16″ lead. The high pressure valves are designed with 1¼″ steam lap and 5/16″ exhaust clearance, while the low pressure valves have the same exhaust clearance, but 3/16″ less steam lap. The valves in each case are actuated by the Walschaert valve gear, and the two sets of gears are so arranged that the high pressure link block is raised while the low pressure one is lowered, when being thrown into forward gear and the two gears consequently counterbalance each other. As the high pressure valve has inside admission, and the low pressure out- is supported by a coil spring, through which the lower end of the bolt passes and which bears up against the bottom of the rear frame rail, the spring cap having a ball joint with the frame.

A flexible support at this point was necessary in order that each of the three boiler supports, namely, the two sliding bearings and the equalizing bolt, might bear its proportion of the load in any variation in alignment of the three.

In order to obviate the necessity of flexible connections in the sand pipes leading to the driving wheels of the front engine, sand is supplied to these wheels from a sand box supported on the front deck plate. The headlight is carried on a bracket

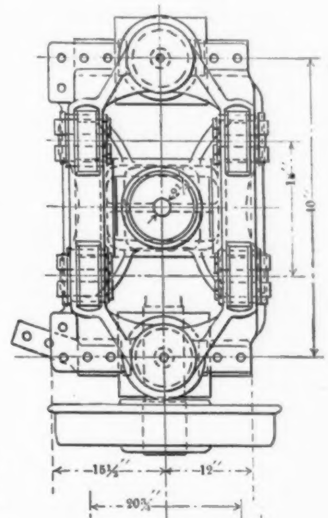
bolted to the front of this sand box.

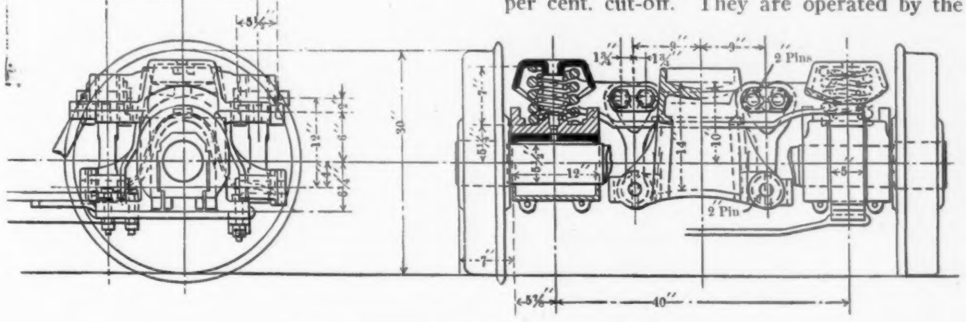
Another interesting detail of the design is the arrangement of the draw gear between the engine and tender, in which the draw bar pin is horizontal and is inserted through the side walls of the foot plate instead of being vertical and put in through the top of the foot plate as is the usual practice. This arrangement facilitates the extraction of the draw bar pin when it is necessary to disconnect the engine from the tender. The construction is clearly shown in the accompanying illustration which needs no further explanation.

The tender is of the railroad company's design throughout, and is provided with a water bottom tank having a water capacity of 9,500 gallons. The tender frame is of steel, the center sills being constructed of 15" channels and the side sills of 10" channels. The tender trucks are of the four-wheel equalized type.

The general dimensions, weights and ratios are given in the following table:

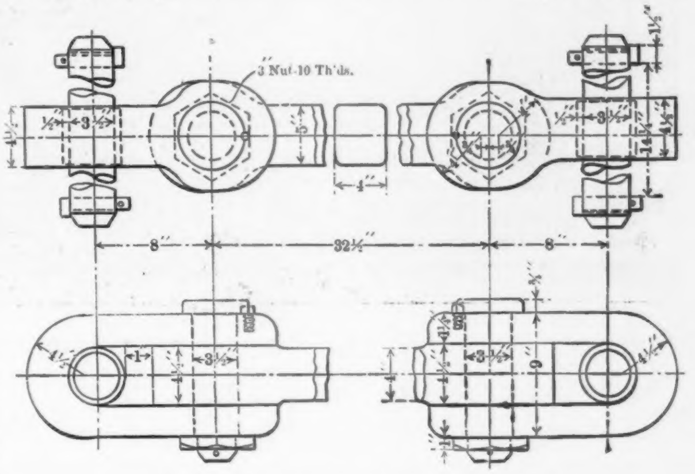
GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	70,800 lbs.
Weight in working order	330,000 lbs.
Weight on drivers	312,000 lbs.
Weight on leading truck	18,000 lbs.
Weight of engine and tender in working order	492,300 lbs.
Wheel base, driving	31 ft. 9 in.
Wheel base, total	39 ft. 11 in.
Wheel base, engine and tender	73 ft. 2 11/16 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.41
Total weight ÷ tractive effort	4.67
Tractive effort × diam. drivers ÷ heating surface	753.00
Total heating surface ÷ grate area	88.50
Firebox heating surface ÷ total heating surface, per cent	4.42
Weight on drivers ÷ total heating surface	61.90





FRONT ENGINE TRUCK—VIRGINIAN MALLET.

Total weight ÷ total heating surface	65.10
Volume equiv. simple cylinders, cu. ft	20.46
Total heating surface ÷ vol. cylinders	247.00
Grate area ÷ vol. cylinders	2.79
CYLINDERS.	
Kind	Mellin Compound
Diameter and stroke	22 & 35 × 30
VALVES.	
Kind	H. P. Piston, L. P. Slide
Greatest travel	6 in.
Outside lap	1¼ & 1 1/16 in.
Inside clearance	5/16 in.
Lead, constant	3/16 in.
WHEELS.	
Driving, diameter over tires	54 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	5½ x 12 in.
BOILER.	
Style	E. W. T.
Working pressure	200 lbs.
Outside diameter of first ring	76 in.
Firebox, length and width	114 & 72 in.
Firebox plates, thickness	⅜ & 9/16 in.
Firebox, water space	F.—6, S. & B.—5 in.



DRAW BAR BETWEEN ENGINE AND TENDER.

Tubes, number and outside diameter	390—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4,842 sq. ft.
Heating surface, firebox	223.9 sq. ft.
Heating surface, total	5,065.9 sq. ft.
Grate area	57 sq. ft.
Smokestack, diameter	16 in.
Smokestack, height above rail	186½ in.
Center of boiler above rail	116 in.
TENDER.	
Tank	Water Bottom
Frame	15 in. Center Sills, 10 in. Side Sills
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,500 gals.
Coal capacity	14 tons

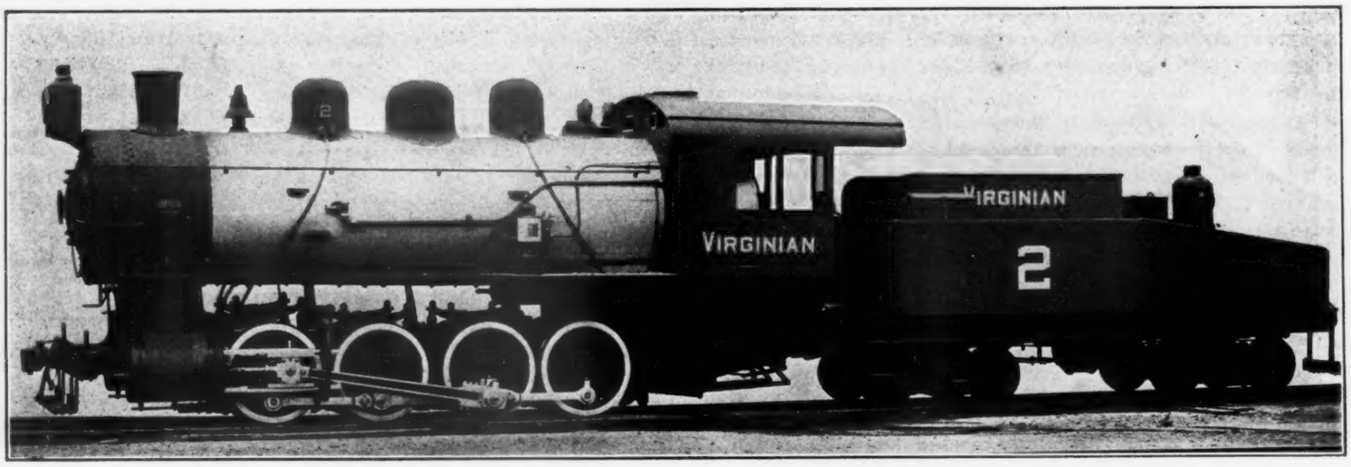
EIGHT-WHEEL SWITCHING LOCOMOTIVES.

For switching service in the yards at Sewell's Point, Roanoke and Princeton, this company has recently received three heavy eight-coupled switching locomotives from the same builders, one of which is shown in the accompanying illustration.

The cylinders are 22 inches in diameter by 28 inches stroke and with a boiler pressure of 200 lbs. and driving wheels 51 inches in diameter, the theoretical maximum tractive power is 45,200 lbs. This makes them the most powerful engines of their type on our records.

Steam is distributed to the cylinders by means of 12" piston valves, having inside admission and a maximum travel of 5½ inches. The valves are designed with a 15/16" steam lap and no exhaust lap or clearance and are set to give a ¼" lead at 50 per cent. cut-off. They are operated by the Stephenson's shifting link gear arranged with a transmission bar. The valve chests are equipped with by pass valves of the P. R. R. standard type.

The frames which are of cast steel with single front rail are 4½ inches wide. Following the ordinary practice in this type of engine, the first and second driving wheels on either side are equalized together and the first pair are cross equalized; while the third and fourth driving wheels are equalized together, but the cross equalization is omitted. This gives a three point suspended engine.



POWERFUL EIGHT-WHEEL SWITCHING LOCOMOTIVE—VIRGINIAN RAILWAY.

Lubricators for oiling the driving wheel flanges are provided on the front and back driving wheels. The device consists of a 2" wrought iron pipe, filled with oiled waste, the bottom end of the pipe being cut out to fit over the flange of the tire. This pipe is held in position by a wrought iron bracket, which is loosely pivoted on its point of support so as to allow the pipe to accommodate itself to the movement of the wheel relative to the frame.

The boiler is of the radial stayed, straight top type with sloping back head and vertical throat sheet. The barrel, which is made in two courses, measures 74 inches in diameter outside at the first course. It contains 354 tubes, 2 inches in diameter and 15 feet long. The total heating surface of the boiler is 2,940 square feet, of which the tubes provide 2,763 square feet and the fire box the remainder. The fire box is narrow and is placed between the driving wheels and over the frames. It is 108 inches long and 42 inches wide and provides a grate area of 31.5 square feet.

The water spaces around the fire box are 4 inches wide at the mud ring on the front and 3½ inches wide on the back and sides, increasing in width at the crown sheet to 4½ inches in the back and about 6½ inches on the sides.

A limited number of flexible staybolts are used in the back head and throat sheet. In the back head they are located in the outside row all around and also around the fire box door; while in the throat sheet, the first three rows down from the waist are flexible stays.

The fire box is supported by a buckle plate at the back end and by sliding bearings on either side, ahead of the center of the fire box and just back of the rear driving wheels.

Between the fire box and the cylinders, the boiler is supported by two waist sheets, one just back of the main driving wheels and the other at the guide yoke. The rear one of these sheets extends down to the bottom rails of the frames and is secured to a cross tie between them as well as to a cross tie spanning the upper rails of the frames. A similar arrangement is employed at the guide yoke, though the waist sheet is not in one continuous piece.

The tender is equipped with a sloping back tank, having a water capacity of 5,000 gallons and space for ten tons of coal. The tender frame is built of steel, with center sills of 15-inch channels and side sills of 10-inch channels. The tender trucks are of the arch-bar type with cast steel bolsters. The arrangement of the draw-gear between engine and tender is similar to that employed in the Mallet locomotives described above.

The general dimensions, weights and ratios of these locomotives are as follows:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Switching
Fuel	Bit. Coal
Tractive effort	45,200 lbs.
Weight in working order	182,300 lbs.
Weight on drivers	182,300 lbs.
Weight of engine and tender in working order	293,700 lbs.
Wheel base, driving	14 ft.
Wheel base, engine and tender	49 ft. 6 11/16 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.03
Tractive effort × diam. drivers ÷ heating surface	785.00
Total heating surface ÷ grate area	93.20
Firebox heating surface ÷ total heating surface, per cent	6.04
Weight on drivers ÷ total heating surface	62.00
Volume both cylinders, cu. ft.	12.35
Total heating surface ÷ vol. cylinders	239.00
Grate area ÷ vol. cylinders	2.55
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 28 in.
VALVES.	
Kind	Piston
Kind of gear	Stephenson
Greatest travel	5½ in.
Outside lap	15/16 in.
Inside clearance	0 in.
Lead at 50% C. O	¼ in.
WHEELS.	
Driving, diameter over tires	51 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	9½ x 12 in.
Driving journals, others, diameter and length	9 x 12 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	74 in.
Firebox, length and width	108 x 42 in.
Firebox plates, thickness	⅜ & 9/16 in.
Firebox, water space	4 & 3½ in.
Tubes, number and outside diameter	564—2 in.
Tubes, length	15 ft.
Heating surface, tubes	2,763 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	2,940 sq, ft.
Grate area	31.5 sq. ft.
Smokestack, diameter	17 in.
Smokestack, height above rail	178½ in.
Center of boiler above rail	109 in.
TENDER.	
Tank	Sloping Back
Frame	15 in. Center & 10 in. Side Sills
Wheels, diameter	33 in.
Journals, diameter and length	5 x 9 in.
Water capacity	5,000 gals.
Coal capacity	10 tons

Railroad Co-operates with Forest Service.—For the purpose of reducing the number of fires along the right of way in the Arkansas national forest, the Forest Service has recently entered into a co-operative agreement with the Kansas City Southern Railroad which provides that the railroad shall clear its right of way of all inflammable material for a distance of fifty feet on each side of the track and burn over an additional 100 feet wherever necessary. A provision is made for the use of efficient spark arresters, and that fires shall be reported to the nearest station agent, who will notify Forest officers and section crews. The maintenance of a Forest Service telephone line along the right of way will also be allowed. On its side, the Forest Service will patrol and supervise the clearing of the right of way, supply tools, and maintain and operate sufficient telephones as well as grant the railroad the timber free of charge, where it is necessary to clear the right of way. This agreement is for a period of ten years and has already been put into effect. Six telephones have been established along the line and excellent results are being obtained. Inasmuch as a great majority of the fires on the Arkansas national forest can be laid to this source, it is thought that a great reduction in the area of burned over land will be made during the coming season. The Forest Service will be glad to have similar co-operation with other railroads traversing national forests.

WEIGHTS OF ROUND IRON IN LBS.

LENGTH IN FEET

DIAMETER

SIZE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1/4"	.167	.334	.501	.668	.835	1.00	1.17	1.34	1.50	1.67	1.84	2.00	2.17	2.34	2.51	2.67	2.84	3.01	3.17	3.34
3/8"	.370	.740	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.70	4.07	4.44	4.81	5.18	5.55	5.92	6.29	6.66	7.03	7.40
1/2"	.660	1.32	1.98	2.64	3.30	3.96	4.62	5.28	5.94	6.60	7.26	7.92	8.58	9.24	9.90	10.56	11.22	11.88	12.54	13.20
5/8"	1.04	2.08	3.12	4.16	5.20	6.24	7.28	8.32	9.36	10.40	11.44	12.48	13.52	14.56	15.60	16.64	17.68	18.72	19.76	20.80
3/4"	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00	25.50	27.00	28.50	30.00
7/8"	2.03	4.06	6.09	8.12	10.15	12.18	14.21	16.24	18.27	20.30	22.33	24.36	26.39	28.42	30.45	32.48	34.51	36.54	38.57	40.60
1"	2.62	5.24	7.86	10.48	13.10	15.72	18.34	20.96	23.58	26.20	28.82	31.44	34.06	36.68	39.30	41.92	44.54	47.16	49.78	52.40
1 1/8"	3.31	6.62	9.93	13.24	16.55	19.86	23.17	26.48	29.79	33.10	36.41	39.72	43.02	46.34	49.65	52.96	56.27	59.58	62.89	66.20
1 1/4"	4.09	8.18	12.27	16.36	20.45	24.54	28.63	32.72	36.81	40.90	44.99	49.08	53.17	57.26	61.35	65.44	69.53	73.62	77.71	81.80
1 3/8"	4.95	9.90	14.85	19.80	24.75	29.70	34.65	39.60	44.55	49.50	54.45	59.40	64.35	69.30	74.25	79.20	84.15	89.10	94.05	99.00
1 1/2"	5.89	11.78	17.67	23.56	29.45	35.34	41.23	47.12	53.01	58.90	64.79	70.68	76.57	82.46	88.35	94.24	100.1	106.0	111.9	117.8
1 5/8"	6.91	13.82	20.73	27.64	34.55	41.46	48.37	55.28	62.19	69.10	76.01	82.92	89.83	96.74	103.7	110.6	117.5	124.4	131.3	138.2
1 3/4"	8.02	16.04	24.06	32.08	40.10	48.12	56.14	64.16	72.18	80.20	88.22	96.24	104.3	112.3	120.3	128.3	136.3	144.4	152.4	160.4
1 7/8"	9.20	18.40	27.60	36.80	46.00	55.20	64.40	73.60	82.80	92.00	101.2	110.4	119.6	128.8	138.0	147.2	156.4	165.6	174.8	184.0
2"	10.47	20.94	31.41	41.88	52.35	62.82	73.29	83.76	94.23	104.7	115.2	125.7	136.1	146.6	157.1	167.5	178.0	188.5	198.9	209.4
2 1/4"	13.25	26.50	39.75	53.00	66.25	79.50	92.75	106.0	119.3	132.5	145.8	159.0	172.3	185.5	198.8	212.0	225.3	238.5	251.8	265.0
2 1/2"	16.36	32.72	49.08	65.44	81.80	98.16	114.5	130.9	147.2	163.6	180.0	196.3	212.7	229.0	245.4	261.8	278.1	294.5	310.8	327.2
2 3/4"	19.80	39.60	59.40	79.20	99.00	118.8	138.6	158.4	178.2	198.0	217.8	237.6	257.4	277.2	297.0	316.8	336.6	356.4	376.2	396.0
3	23.56	47.12	70.68	94.24	117.8	141.4	164.9	188.5	212.0	235.6	259.2	282.7	306.3	329.8	353.4	377.0	400.5	424.1	447.6	471.2

LENGTH IN INCHES — LENGTH IN FRACTIONS OF ONE INCH.

DIAMETER

SIZE	1	2	3	4	5	6	7	8	9	10	11	12	SIZE	1/8	1/4	3/8	1/2	5/8	3/4	7/8
1/4"	.014	.028	.042	.056	.070	.084	.097	.111	.125	.139	.153	.167	1/4"	.002	.004	.005	.007	.009	.011	.012
3/8"	.031	.062	.093	.123	.154	.185	.216	.247	.278	.308	.339	.370	3/8"	.004	.008	.012	.016	.019	.023	.027
1/2"	.055	.110	.165	.220	.275	.330	.385	.440	.495	.550	.605	.660	1/2"	.007	.014	.021	.028	.034	.041	.048
5/8"	.087	.173	.260	.347	.433	.520	.607	.693	.780	.867	.953	1.04	5/8"	.011	.022	.033	.044	.054	.065	.076
3/4"	.125	.250	.375	.500	.625	.750	.875	1.00	1.13	1.25	1.38	1.50	3/4"	.016	.031	.047	.063	.078	.094	.109
7/8"	.169	.338	.508	.677	.846	1.02	1.18	1.35	1.52	1.69	1.86	2.03	7/8"	.021	.042	.063	.085	.106	.127	.148
1"	.218	.437	.655	.873	1.09	1.31	1.53	1.75	1.97	2.18	2.40	2.62	1"	.027	.055	.082	.109	.136	.164	.191
1 1/8"	.276	.552	.828	1.10	1.38	1.66	1.93	2.21	2.48	2.76	3.03	3.31	1 1/8"	.035	.069	.104	.138	.173	.207	.242
1 1/4"	.341	.682	1.02	1.36	1.70	2.05	2.39	2.73	3.07	3.41	3.75	4.09	1 1/4"	.043	.085	.128	.171	.213	.256	.298
1 3/8"	.413	.825	1.24	1.65	2.06	2.48	2.89	3.30	3.71	4.13	4.54	4.95	1 3/8"	.052	.103	.155	.207	.258	.310	.361
1 1/2"	.490	.982	1.47	1.96	2.45	2.95	3.44	3.93	4.42	4.90	5.40	5.89	1 1/2"	.061	.123	.184	.245	.306	.368	.429
1 5/8"	.576	1.15	1.73	2.30	2.88	3.46	4.03	4.61	5.18	5.76	6.33	6.91	1 5/8"	.072	.144	.216	.288	.360	.432	.504
1 3/4"	.668	1.34	2.01	2.67	3.34	4.01	4.68	5.35	6.02	6.68	7.35	8.02	1 3/4"	.084	.167	.251	.334	.418	.501	.585
1 7/8"	.767	1.53	2.30	3.07	3.83	4.60	5.37	6.13	6.90	7.67	8.43	9.20	1 7/8"	.096	.192	.288	.384	.479	.575	.671
2"	.873	1.75	2.62	3.49	4.36	5.24	6.11	6.98	7.85	8.73	9.60	10.47	2"	.109	.218	.327	.437	.546	.655	.764
2 1/4"	1.10	2.21	3.31	4.42	5.52	6.63	7.73	8.83	9.94	11.04	12.15	13.25	2 1/4"	.138	.275	.413	.550	.688	.825	.963
2 1/2"	1.36	2.73	4.09	5.45	6.82	8.18	9.54	10.90	12.27	13.63	15.00	16.36	2 1/2"	.170	.340	.510	.680	.850	1.02	1.19
2 3/4"	1.65	3.30	4.95	6.60	8.25	9.90	11.55	13.20	14.85	16.50	18.15	19.80	2 3/4"	.206	.413	.619	.825	1.03	1.24	1.44
3"	1.96	3.93	5.89	7.85	9.82	11.78	13.83	15.71	17.67	19.63	21.60	23.56	3"	.245	.490	.735	.980	1.23	1.47	1.72

COMPUTED BY S. HUNTER MICHAELS

EXAMPLE: *Find the weight of a piece of round iron 1⅝ in. in diameter and 17 ft. 7¾ in. long:—From the upper part of the table the weight for a piece of iron of this diameter 17 ft. long is 117.5 lbs.; the weight of a piece 7 in. long is 4.03 lbs., as shown by the part of the table in the lower left hand corner; the weight of a piece ¾ of an inch long is .432 lbs., as shown by the part of the table in the lower right hand corner; therefore the total weight of the rod would be 117.5 + 4.03 + .432, or 121.962 lbs.*

EXAMPLE: *Find the weight of a piece of 1 in. iron 31 ft. long:—From the upper part of the table a piece 3 ft. long weighs 7.86 lbs. Moving the decimal point one place to the right makes the weight of a piece 30 ft. long 78.6 lbs. From the same part of the table the weight of a piece 1 ft. long equals 2.62; therefore the weight of the entire rod is 78.6 + 2.62, or 81.22 lbs.*

ARTICULATED ELECTRIC LOCOMOTIVE FOR THE DETROIT RIVER TUNNEL.

A series of acceptance tests has been completed recently by the General Electric Company and the Detroit River Tunnel Company, jointly, upon electric locomotive No. 7500, the first of six locomotives for the Michigan Central Railroad, one of the New York Central lines, and to be operated in the tunnel under the Detroit River now under construction. The electrical equipment of this locomotive, which is the most powerful in point of tractive effort ever designed for operation by direct current, was built and installed by the General Electric Company. The mechanical details, including the trucks and cab structure, are the product of the Schenectady works of the American Locomotive Company.

The Detroit River tunnel will connect the West Detroit yards of the Michigan Central Railroad with the new Windsor yards in Windsor, Ont. The electrified zone, embracing the tunnel with its approaches, terminal tracks and sidings, will cover a distance of approximately 33,000 ft. Maximum grades are encountered on the approaches, where a 2 per cent. grade extends for approximately 2,000 ft. at each end of the tunnel.

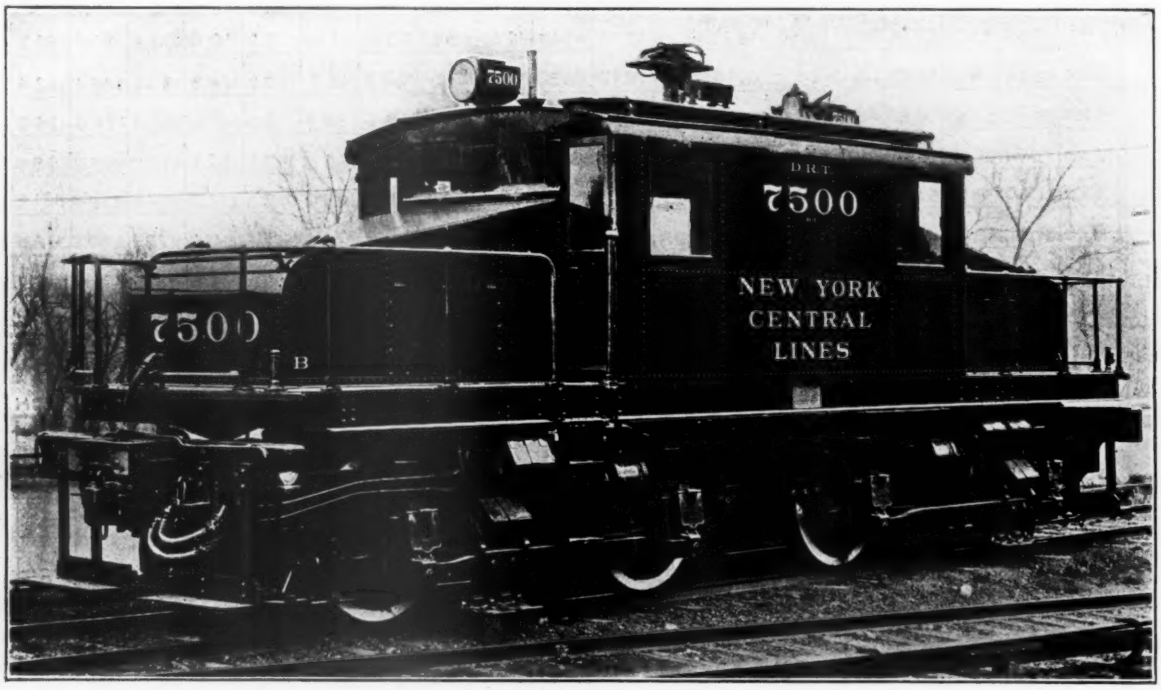
The locomotives are designed for hauling both freight and passenger trains through this tunnel, and also for switching service at the terminals. The specifications under which they were built demand a maximum service, consisting of hauling an 1,800-ton trailing train up the 2 per cent. grades at a speed of not less than 10 m. p. h., with two locomotives operating as multiple units. Their capacity is such that they are capable of repeating trips with this weight of train continuously with a lay-over of 15 minutes at each end without undue heating of the motors.

The articulated running gear may be considered as consisting of two four-wheel trucks coupled together; but the method of coupling and the relation of the equalizing systems on the two trucks make it necessary to consider the two trucks together. The truck side frames are heavy steel castings of a truss pattern. In order to obtain the necessary weight on drivers the members of this frame are made heavier than actually required for strength, the top member having a section 5 in. x 7 in., while the other members are proportionally heavy. This gives a peculiarly massive and substantial appearance to the whole running gear. The truck end frames and bolsters are castings of heavy box girder type, rigidly bolted to the side frames and fitted in such a manner as to relieve the bolts of shear. Draft gear buffers and all truck frame members are calculated for buffing stresses of 500,000 lb. and pulling stresses in proportion.

The system of spring suspension is of the locomotive type, the weight being carried on semi-elliptic springs resting on the journal box saddles. The system of equalization by which these springs are connected together is ingenious and interesting. The *A* end of the running gear—or what may be called the forward truck—is side equalized, the two springs on each side being connected together through an equalizer beam. This equalizes the distribution of weight between the two wheels on one side, giving to this truck a two-point support, and consequently leaving it in a condition of unstable equilibrium as regards tilting stresses—that is, stresses tending to tip the truck forward or backward. The *B* end of the running gear, or what may be called the rear truck of the locomotive, is cross-equalized, the two springs on the rear axle being connected together through an equalizer beam. The other two springs on this truck are independent and are connected directly to the truck frame. This results in a three-point suspension on the rear truck, leaving it in a condition of stable equilibrium, capable of resisting stresses in any direction, whether rolling or tilting. The two trucks are coupled together by a massive hinge, so designed as to enable the rear truck to resist any tilting tendency of the forward truck. This hinge combines the two trucks into a single articulated running gear, having lateral flexibility with vertical rigidity. It will be noted from the above description that the running gear has what may be called a compound three-point suspension. The rear truck has in itself a three-point suspension, while the forward and rear trucks together form an articulated frame having a three-point suspension, consisting of the two-point support of the forward truck and the independent equalization of the rear truck.

The draft rigging is mounted upon the outer end frames of the trucks which insures that all pulling and buffing stresses are transmitted on the same horizontal line through the draft rigging, side frames and connecting hinge pin of the trucks. The center pins and cab platform framing are entirely relieved of all longitudinal stresses except those due to the weight of the cab, platform and equipment.

Center pins and side bearings are provided on the running gear for the support of the cab. The center pin on the *A* end is a swivel pin, having a turning motion only, while that one on the *B* end has a turning and sliding motion. This construction allows the longitudinal motion necessary to take care of the



ARTICULATED ELECTRIC LOCOMOTIVE—DETROIT RIVER TUNNEL.

variation in distance between the truck center pins occurring as the locomotive passes around curves. The side bearings on the *A* end have a clearance of about ⅛ in. when the cab is level, while those on the *B* end have a clearance of about ½ in. The result of this arrangement is that under ordinary circumstances the cab is carried on a three-point suspension, since the side bearings on the *A* end support all normal rolling action of the cab, the side bearings on the *B* end coming into play under abnormal conditions only.

The cab platform is built of four 10-in. longitudinal channels running the whole length of the locomotive, which are tied together by the end channels and bolster plates. Such ballast as is necessary to bring the weight of the locomotive up to the required amount is bolted to the two center sills. A floor plate, consisting of two sheets of ⅜-in. steel, is riveted to the platform sills, and serves to stiffen and square the platform framing. In the operating cab a ⅞-in. wood flooring is placed over this steel floor. The sides and ends of the cab are built of ⅛-in. steel plate, supported by a framework of small angles, while the roof is of No. 8 gauge steel. The main operating cab occupies the central portion of the locomotive and covers a floor space of 15 ft. 6 in. x 10 ft. It is fitted with windows on each side and two windows and two glazed doors in each end, allowing a practically unobstructed view in every direction. The cab contains the engineer's seat, and such apparatus as is required in the operating compartment of the locomotive. Auxiliary cabs extend from the main cab to the ends of the locomotive, and occupy a floor space of 9 ft. x 6 ft. each. These cabs house the air tank, sand boxes, rheostats and contactors. Hinged perforated doors in the sides of the auxiliary cabs give access to the rheostats and the connections back of the contactors, while folding doors between the auxiliary and main cabs allow access for inspection of the contactors. The edges of the auxiliary cabs are bolted to the platform and main cab, so that they can be readily removed when it is necessary to make heavy repairs.

The difference in width of the auxiliary and main cabs allows room for a narrow platform or running board, extending from the main cab along the sides of the auxiliary cabs to the ends of the locomotive. This running board is protected by hand rails running around the outside of the locomotive from one side of the main cab to the other. The doors of the main cab open to this platform, and the steps reaching the ground are located near the doors. One marked advantage of this construction is the unobstructed view given the engineer, both ahead and to the rear.

A type C-79 controller and the operating handles for the air brakes are located in the cab within easy reach of the engineer's seat. Sander valves are located beside the engineer, and over his head are switches for the headlight and control circuits. Directly in front are illuminated air gauges, ammeter and a foot-operated trolley valve for raising and lowering the overhead trolley. Sanders are arranged to sand the rails in front of the leading wheels on either truck.

A two-stage, four-cylinder compressor, geared to a 600-volt, direct-current series motor, is located in the center of the main cab. It has a capacity of 100 cu. ft. piston displacement per minute when pumping against a tank pressure of 135 lb. Ample circulating pipes are provided for cooling the air between stages and between pumps and tanks, in order that a moderate temperature may be maintained. The compressor is controlled by a governor, consisting of a pneumatically operated piston controlling the contact of the motor circuit switch, and so arranged as to close or open this circuit at any predetermined limits of pressure.

The motor equipment consists of four GE-209 motors having a rating of approximately 300 h.p. each. At its one-hour rating the motor will develop a torque of 4,050 lb. at 1-ft. radius. The gearing between motor and axle has a 4.37 reduction, and the driving wheels are 48 in. in diameter. With this reduction, each motor will develop a tractive effort of 9,000 lb. at the rail head, which gives a total tractive effort for the four motors of 36,000 lb. at 12 m. p. h. The motors have an overload capacity sufficient to slip the driving wheels, and the locomotive can develop at the slipping point of the wheels an instantaneous tractive effort of 50,000 lb. to 60,000 lb. The maximum speed of the locomotive, running light upon a level track, is about 35 m. p. h. There are two gears and pinions per motor, one at either end of the armature shaft.

The motors are designed for forced ventilation. Air is delivered into the motor frames at the end farthest from the commutator, passes between the field coils and around the armature, and finally escapes through suitable discharge openings over the commutator. The blower used for this purpose has a capacity of 2,000 cu. ft. of air per minute at 2¼ in. of water pressure, and is driven by a direct-current series motor. This blower delivers air to the passage between the two center sills, from which the ventilating ducts are tapped off to the motors at appropriate points.

The control system used is the Sprague-General Electric multiple unit type, with two master controllers in the main cab and the contactors in the auxiliary cab. Multiple unit connections have been supplied, so that three locomotives may be operated in unison, if necessary. The problem of starting and accelerating a train of from 1,000 to 1,500 tons weight, which may consist of 40 or 50 cars, is a rather delicate one. Consequently, the control for these locomotives was designed especially to produce a uniform increase of speed and torque during the period of acceleration. The control combinations are arranged so that the motors may be operated four in series, two in series and two in parallel, or four in parallel. There are nine resistance steps in series, eight in series-parallel and seven in the parallel position. In a test run with a train of 1,578 tons weight, consisting of one locomotive and 26 freight cars, the acceleration from a standstill to 10 m. p. h. was accomplished with marked smoothness. The maximum increase of drawbar pull was about 6,500 lb. on the first few steps, after which the maximum throughout the remainder of the acceleration was from 2,000 to 3,000 lb. To an observer standing in the caboose of such a train the rear end of the train is started so gradually that the beginning of the motion is almost imperceptible. The contrast with the results obtained with a steam locomotive is very striking.

The locomotive is equipped with third-rail shoes to take current from an inverted third-rail. It is also fitted with an overhead trolley, which, as stated previously, can be raised or lowered by a foot-operated valve in front of the motorman.

General data of the locomotive are given in the following table:

Number of motors	4
Gear ratio	4.87
Number of driving wheels	8
Diameter of driving wheels	48 in.
Total wheel base	27 ft. 6 in.
Rigid wheel base	9 ft. 6 in.
Length inside coupler knuckles	39 ft. 6 in.
Length of main cab	15 ft. 6 in.
Height of cab	12 ft. 6 in.
Maximum height, trolley up	15 ft. 6 in.
Maximum height, trolley retracted	14 ft. 10⅛ in.
Maximum width	10 ft. 2⅝ in.
Width of cab	10 ft. 1 15/16 in.
Total weight	199,000 lb.

High Speed Steel Cutters for Woodworking.—In the January issue, page 78, we described the high speed steel cutters for planing and surfacing, as made by Samuel J. Shimer & Sons, of Milton, Pa. The cost of high speed steel makes it necessary to use thin blades which fit in carefully designed holders. These thin knives have been found to be far more efficient than the old type, and the above mentioned company has decided to designate them as Bedee knives.

Wireless Telegraphy.—It is proposed to build at Washington a concrete tower, in connection with a wireless telegraph system, which will rise 600 ft., overtopping the Washington monument by 45 ft. Installations will also be made on board the various vessels of the fleet, so that it will be possible to telegraph 3,000 miles seaward and from vessels to land a distance of 1,000 miles.